S
333.7
U3lse
1976

STATUS OF ELECTRIC POWER IN THE MISSOURI RIVER BASIN

STATE DOCUMENTS COLLECTION

MAY 3 1982

MONTANA STATE LIBRARY
930 E Lyndale Ave.
Helena, Montana 59601

U.S. DOCUMENTS COLLECTION
MONTANA STATE LIBRARY

MONTANA STATE LIBRARY
930 East Lyndale Avenue
Helena, Montana 59601

PLEASE RETURN

- CAPACITY
- FUTURE NEEDS
- PLANNING
- RESEARCH
- PROBLEMS AND ISSUES

Missouri River Basin Commission
October 1976

Montana State Library
3 0864 1004 5386 2

The Missouri River Basin Commission is the principal agency for the coordination of Federal, State, interstate, local and nongovernmental plans for the development of water and related land resources in the area served by the Missouri River and its tributaries. As an independent regional commission, it also provides a forum in which States meet with Federal agencies to conduct and coordinate water and related land resources planning. The Commission's Chairman is appointed by the President; its Vice-Chairman is elected from among State members.

MRBC members are Colorado; Iowa; Kansas; Minnesota; Missouri; Montana; Nebraska; North Dakota; South Dakota; Wyoming; Department of Agriculture; Department of the Army; Department of Commerce; Energy Research and Development Administration; Environmental Protection Agency; Federal Power Commission; Department of Health, Education and Welfare; Department of Housing and Urban Development; Department of the Interior; Department of Transportation; Yellowstone River Compact Commission; Big Blue River Compact Administration. Canada is an observer.

STATUS OF ELECTRIC POWER IN THE MISSOURI RIVER BASIN

- Capacity
- Future Needs
- Planning
- Research
- Problems and Issues

MISSOURI RIVER BASIN COMMISSION
10050 Regency Circle, Suite 403
Omaha, Nebraska 68114

October 1976

John W. Neuberger
Chairman

Archie D. Chelseth
Vice-Chairman

FOREWORD

Those individuals in the Missouri River Basin who are deeply involved in the electrical power industry are well aware of the problems facing the area and what is being done to solve those problems. However, those on the periphery of the industry engaged in related activities, such as water and land use planning, are often not aware of what is being accomplished now or what is being planned for the future. A wide spectrum of the interested public must also be included in this second category.

The purpose of this publication is to provide information on the status of electric power generation, future needs, and potentials for meeting these needs. It also highlights some of the research and development being conducted to help solve present and future problems and discusses presently underway environmental studies related to power production and energy development. Another important purpose is to draw together state concerns regarding electrical power needs, problems, and issues and to assess their similarities.

Stored potential energy must be obtained from some source and transformed to generate electricity. Those sources of most importance are coal, falling water, natural gas, fuel oil, and nuclear energy. Their use and some cost data is provided. Other forms of energy such as solar, tidal, and geothermal are being researched and are discussed in a section on research activities.

This publication is the first of its kind in the Missouri River Basin. It is planned to update and improve the report annually if it is found to meet the need in filling an information gap. Although presently limited to electric power, it is anticipated that the report could be expanded to include other forms of energy as more information becomes available in the future.

ACKNOWLEDGEMENTS

This report was prepared by the Energy and Water Committee of the Missouri River Basin Commission.

Walter Belter (Chairman)	Energy Research & Development Administration
Gus Karabatsos	Department of the Army
Tom Weaver	Department of the Interior
Cooper Wayman	Environmental Protection Agency
Lenard Young	Federal Power Commission
William Brabham	Iowa Conservation Commission
Vern Butler	South Dakota Water Resources Commission
George Christopulos	Wyoming State Engineer's Office

Carroll Hamon	MRBC Staff Coordinator

Photo Credits:

Omaha Public Power District
Basin Electric Power Cooperative
U.S. Department of the Interior

TABLE OF CONTENTS

	Page
FOREWORD	i
ACKNOWLEDGEMENTS	ii
GLOSSARY OF TERMS AND ABBREVIATIONS	vi
CHAPTER 1. ELECTRICAL POWER PLANNING AND COORDINATION	1
CHAPTER 2. THE EXISTING ELECTRIC POWER SITUATION	3
EXISTING AND PROJECTED ELECTRIC POWER REQUIREMENTS	3
EXISTING ELECTRIC POWER SUPPLY	4
Fuel Used for Electric Generation	6
Cooling Water Used for Steam-Electric Generation	6
Electric Plant Construction and Operating Costs	8
ENVIRONMENTAL CONTROL FACILITIES	12
Air Emission Control Facilities	12
Thermal Discharge Control Facilities	12
ACTUAL FOSSIL FUEL COSTS FOR ELECTRIC GENERATING PLANTS	14
CHAPTER 3. POWER RESOURCES FOR FUTURE DEVELOPMENT	14
TOTAL ENERGY, ELECTRIC ENERGY, AND NUCLEAR POWER PROJECTIONS FOR THE UNITED STATES - 1975	15
Total Energy Patterns	15
Electric Energy Patterns	16
Total Electrical Capacity	18
Nuclear Energy Projections	18
PRESENT AND PLANNED GENERATING CAPACITY	19
CHAPTER 4. FEDERAL ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION	25
INTRODUCTION AND LEGISLATIVE BACKGROUND	25
HIGHLIGHTS OF FEDERAL ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION	26
Fossil Fuels	26
Nuclear Energy	28
Solar Energy	30
Geothermal Energy	33
Wind	34
Broad Energy Studies	34
Energy Conservation	35

Page

CHAPTER 5. ENVIRONMENTAL CONCERNS RELATED TO POWER PRODUCTION AND ENERGY DEVELOPMENT. 39

COAL. 40
PETROLEUM AND NATURAL GAS 46
NUCLEAR 46
ALTERNATIVE ENERGIES. 47
LAND USE. 47

CHAPTER 6. STATE CONCERNS REGARDING ELECTRICAL POWER NEEDS, PROBLEMS, AND ISSUES. 49

COLORADO. 49
IOWA. 52
KANSAS. 53
MINNESOTA 54
MISSOURI. 54
MONTANA 55
NEBRASKA. 56
NORTH DAKOTA. 60
SOUTH DAKOTA. 62
WYOMING 63
COMMON STATE CONCERNS 65

LIST OF TABLES

		Page
Table 1	EXISTING AND PROJECTED ELECTRIC POWER REQUIREMENTS.	4
Table 2	EXISTING ELECTRIC POWER SUPPLY.	4
Table 3	1974 FOSSIL FUEL USAGE AT STEAM PLANTS 25 MW OR GREATER.	6
Table 4	STEAM-ELECTRIC COOLING WATER USE IN THE MISSOURI RIVER BASIN.	7
Table 5	WATER USE RATES FOR 1000 MW STEAM-ELECTRIC PLANT.	8
Table 6	ELECTRIC GENERATING PLANT FUEL COSTS.	14
Table 7	TOTAL ENERGY PROJECTIONS (10^{15}BTU).	16
Table 8	PROJECTED ELECTRICITY PRODUCTION GROWTH	17
Table 9	PROJECTED TOTAL ELECTRIC GENERATING CAPACITY. . .	18
Table 10	PROJECTED INSTALLED NUCLEAR CAPACITY.	19
Table 11	FUTURE ELECTRIC POWER DEMAND.	20
Table 12	SCHEDULED OR PLANNED ADDITIONAL GENERATING CAPACITY.	20
Table 13	ADDITIONAL HYDRO-POWER POTENTIAL.	22

LIST OF FIGURES

Figure 1	MAJOR ELECTRIC FACILITIES WITHIN THE MISSOURI RIVER BASIN.	Proceeding Page 6
Figure 2	SOLAR HEATING PROJECTS PRIOR TO FY 76	31

GLOSSARY OF TERMS AND ABBREVIATIONS

Average plant heat rate -- An average measure of generating station thermal efficiency for all plants producing electricity in the basin. Computed by dividing total Btu content of fuel burned (or heat released from a nuclear reactor) by the resulting net kilowatt-hours generated.

Baseline environmental conditions -- The quality and quantity of all environmental resources (soil, water, air, vegetation, fish and wildlife, etc.) at a given point in time within a defined area. An accurate assessment of these conditions is a prerequisite for further planning activities.

Baseload generation -- The minimum amount of electric power or load demand delivered at a given point in a stated period of time, essentially a constant load.

Btu (British thermal unit) -- The amount of energy necessary to raise the temperature of one pound of water by one degree Fahrenheit, from 39.2 to 40.2 degrees Fahrenheit.

Carbon dioxide acceptor process -- A high-Btu coal gasification process where pulverized coal, hot dolomite, and steam are used to produce a low sulfur, low carbon monoxide and carbon dioxide high quality gas.

Cascading outages -- A condition where the out of service loss of one generating unit, transmission line, or other facility for a period of time causes the shutdown of other facilities and equipment.

cfs -- Cubic feet per second.

Closed cycle cooling -- A method for the dissipation of waste heat produced as a by-product of energy production where water circulates in a closed system, with little or no water lost to evaporation.

Coal conversion -- The process of converting coal into either oil or gas by a number of processes including gasification, liquefaction, etc.

Coal mine leachate -- Water pollution wastes resulting from coal mining operations; the type of waste is highly dependent on the composition of the overlying soil; comprised mainly of acid drainage, sulfates, calcium, and magnesium ions.

Combined cycle fossil plants -- Those generating facilities that use two power systems, usually a combination of gas turbine and steam turbine cycles.

Combustion turbine -- Gas driven turbine, similar to the jet aircraft engine, where high pressure, high temperature combustion gas expands and drives a turbine similar to the process in a steam turbine.

Commercialization -- The process of providing or making available sufficient commercial quantities of coal-converted gas.

Cooling pond system -- A system utilizing water reservoir ponds for dissipating waste heat. Employed where water supplies are limited. Ponds are constructed so that water can be recirculated between the heating condenser and the pond. Sufficient water inflow is required to replace that lost through natural evaporation and evaporation induced by the addition of heat to the pond.

Cooling tower system -- Utilized for waste heat dissipation where conditions are not favorable for once-through cooling or for construction of cooling ponds.

Wet cooling towers -- A tower system where warm water is brought in direct contact with a flow of air, and heat is dissipated principally by evaporation.

Dry cooling towers -- A tower system where water circulates in a closed system with cooling provided by a flow of air created either by mechanical or natural draft. Operating much like an automobile radiator, no water is lost by evaporation.

Electric system capacity factor -- The ratio of the average load on electrical generating equipment for the period of time considered, to the capacity of the equipment comprising the electric power generating system.

Electrostatic precipitators -- Provide a means of removing particulates from combustion emissions; an electric field is created across a series of wires, tubes, and/or plates and particles that can be ionized respond to the field and are drawn to the tubes for collection and disposal.

Fast breeder reactor -- A nuclear reactor that produces more fissile material than it consumes.

Flue gas desulfurization -- The removal of sulfur from gases, usually carbon dioxide, water vapor, oxides of nitrogen, and other trace gases, which result from combustion processes.

Fluridized bed combustion -- The burning of a body of finely crushed particles with a gas blown through them. The gas separates the particles so that the mixture behaves like a turbulent fluid.

Gaseous emissions -- Combustion emissions in gaseous form, e.g. NO_x, SO_2.

Gasification -- Refers to the conversion of coal to a gas fuel.

Gwh -- Gigawatt-hour(s), equivalent to a billion watts.

High Btu gasification -- The process of converting coal to an equivalent of natural gas, predominantly methane; obtained by methanating synthesis gas; energy content is usually 950-1,000 Btu's per cubic foot.

High-level radioactive wastes -- Radioactive waste produced from reprocessing and containing the fission products.

Hydrocarbonization -- Direct reaction of hydrogen with carbon to form a liquid fuel from coal. The process requires either the addition of hydrogen or the removal of carbon from the coal compounds.

HC (hydrocarbon) -- Organic compound containing only carbon and hydrogen.

H_2S -- Hydrogen sulfide.

In situ -- In the natural or original position; applied to energy resources when they are processed in the location where they were originally deposited.

Inter-ties -- A tie or feeder permitting a flow of energy between the transmission facilities of two electric supply systems. The flow of energy may be in either direction.

kv -- Kilovolt.

Kvh -- Kilovolt-hour(s).

Life time system -- A proposed new pricing system establishing life time rates for the elderly and poor. The rate schedule would minimize the economic impact of rate increases on these groups.

Lignite -- The lowest rank coal, with low heat content and fixed carbon, and high percentages of volatile matter and moisture; an early stage in coal formation.

Liquefaction -- The process by which gas is converted from the gaseous to the liquid phase.

Low Btu gasification -- The process of converting coal to gas, obtained by partial combustion of coal; energy content is usually 100 to 200 Btu's per cubic foot.

Low sulfur coal -- A solid, combustible organic material; coal with a sulfur content generally below one percent.

Magnetohydrodynamics (MHD) -- An electrical generation process where DC electricity is produced directly from thermal energy. (See also open cycle MHD).

Mine-mouth facilities -- Those processing facilities located in the vicinity or area of a mine, usually within several miles.

mcf -- Thousand cubic feet.

mgd -- Million gallons per day.

Mw -- Megawatt(s).

Nitrogen oxides (NO_x) -- Oxides of nitrogen; major air pollutants released by the combustion process.

Once-through cooling -- A system where water is withdrawn from some source, circulated through a condenser where it is heated, and then returned to the source. Generally used where adequate water supplies are available and no significant adverse effects on water quality are expected.

Overburden -- The rock, soil, etc., covering a mineral to be mined.

Open cycle MHD -- A system where fossil fuels are burned at sufficient high temperatures (4,000 to 5,000 degrees Fahrenheit) to ionize the product gases. The hot gas, after passing through the MHD generator, can be used to generate steam for a conventional steam turbine.

Peaking type operation (peak load) -- Electrical production normally operated to provide power during maximum load or demand periods.

Peak (load) pricing -- A pricing schedule designed to reduce demand by instituting increased charges during periods of maximum load. Overall, the goal is to reduce the amount of capital required to add new supply capacity.

Pumped-storage hydro -- A hydroelectric power plant utilizing an arrangement whereby electric energy is generated for peak load use by utilizing water pumped into a storage reservoir during off-peak periods. Such plants can be used to provide reserve generating capacity.

Radon gas -- A radioactive gaseous element formed by the disintegration of uranium.

Renewable resources -- Those resources that can be self-renewed, replaced, or reproduced within a reasonably short period of time. In energy, wind, sunlight, and water in lakes and streams are considered as "flow resources" because they come in a continuous and predictable stream, which continues regardless of whether the resources are used or not; as opposed to non-renewable or non-recurring resources.

Retro-fit programs -- In the context of the report, these programs would include equipment modifications designed to improve or realize fuel use efficiencies.

Saline -- Pertaining to the presence of soluable salts.

Secondary recovery -- Methods of obtaining oil and gas by the augmentation of reservoir energy; often by injecting air, gas, or water into a production formation.

Sulfur oxides -- Oxides of sulfur; major air pollutants associated with electric power generation; mostly sulfur dioxide (SO_2) residuals.

Surface retorting -- In the report context, the term is used to describe coal to gas conversion processing at a location or facility site away from the point of coal removal.

Suspended particulate emissions -- Solid particles, such as ash, released in exhaust gases at fossil-fuel plants during the combustion process.

Tertiary recovery -- Use of heat and other methods (other than fluid injection) to augment oil recovery; presumably occurring after secondary recovery.

Three-phase distribution system -- A phase relationship where one voltage level displaced at 120 degree angles, is supplied. Commonly used in industry and for irrigation pumps.

Transuranic radioactive wastes -- Those radioactive wastes with an atomic number above that of uranium (92); see high-level radioactive wastes.

CHAPTER 1. ELECTRICAL POWER PLANNING AND COORDINATION

Approximately 30 percent of the people living in the United States today can remember when the use of electrical energy was not widespread. Nearly 55 percent of the populace have seen the use of electrical energy increase by about five times between 1950 and the present.

Electrical energy use has become an integral part of everyone's life, and recent fuel shortages affecting generation and costs of electricity have made us keenly aware of our electrical dependency.

Power planning and coordination is a necessary part of the effort to maximize cost savings, reduce duplication of facilities, and increase the reliability and adequacy of bulk power supply systems. This effort is carried out by systems within the basin through several planning organizations. Two examples of early power planning organizations in the Missouri River Basin were the Iowa and Upper Mississippi Power Pools. They have now been replaced by other organizations.

Early in 1963, the U.S. Bureau of Reclamation and representatives of over 100 preference-type (publically owned) power systems executed the Missouri Basin Systems Group Pooling Agreement which led to the formation of a power planning group called the Missouri Basin Systems Group (MBSG). MBSG is concerned with both regional planning and with pooled operation. Its membership is composed of a large number of municipal electric systems, rural electric cooperatives, and the U.S. Bureau of Reclamation. Its two objectives are to achieve coordinated planning for provision of the major power facilities (including thermal generation and high voltage transmission) required to meet the growing needs of the systems group members beyond those met by the federal hydroelectric system, and to provide for coordinated operation of the wholesale power supply system. An example of this coordinated effort is the 500 megawatt Laramie River bulk power facility currently being planned for Platte County, Wyoming. When completed, generation from the plant will be used to meet member system requirements throughout the basin.

Another area planning group supplying bulk power to the basin, the Mid-Continent Area Power Planners, was formed by 22 midwest generation and transmission systems in February 1963 to promote integrated regional planning. In November 1972, the organization's membership was expanded, and it became the Mid-Continent Area Power Pool (MAPP). MAPP is composed of investor-owned utilities, public power districts, cooperative systems, and municipal electric systems overlapping a large part of the MBSG area.

Additional area coordination is achieved through regional reliability councils. The National Electric Reliability Council (NERC) was formed voluntarily by the electric utility industry in 1968 and directs its efforts toward augmentation of the reliability

and adequacy of bulk power supply systems. NERC consists of nine regional reliability councils whose membership comprises essentially all of the major electric power systems in the United States. Portions of four regional councils fall within the Missouri River Basin. The Mid-Continent Area Reliability Coordination Agreement (MARCA) represents the largest area of the basin. It covers all of the states of North Dakota, South Dakota, Minnesota, Nebraska, and Iowa within the basin and some parts of Montana. The Western Systems Coordinating Council (WSCC) includes the western edge of the basin, the Southwest Power Pool (SWPP) includes the southern edge, and the Mid-American Interpool Network (MAIN) includes the southeast corner.

After its formation in 1968, NERC and its regional councils devoted their primary effort toward the prevention of cascading outages and widespread blackouts. With the initiation of environmental legislation in the early 1970's, the emphasis has shifted to matters bearing on the adequacy of the power supply. The industry individually and collectively--through NERC and its councils--is also attempting to measure, assess, and respond to requirements to minimize the impact upon the environment in such areas as air and water quality and to minimize regulatory delays in siting reviews and in the construction of facilities.

CHAPTER 2. THE EXISTING ELECTRIC POWER SITUATION

The electric power facilities serving the Missouri River Basin encompass approximately 560 electric systems. These systems consist of a mixture of investor owned, cooperatively owned, municipal and state owned, and one federally owned hydroelectric system. Of this mixture, about 60 percent are municipal systems, and 30 percent are cooperative systems, with the remaining 10 percent comprised of investor owned systems and one federal system. Measured by actual 1974 energy production, the investor owned systems generate more than 56 percent of the total electric energy produced in the basin. About one-half of the municipal systems, which for the most part are quite small, have generating equipment whose production often is supplemented by external system purchases. The cooperative group is comprised of a few generating and transmission systems and numerous distribution cooperatives varying considerably in size. Figure 1 shows the major existing generating plants and the transmission network in the basin.

EXISTING AND PROJECTED ELECTRIC POWER REQUIREMENTS

The service areas of the electric power systems serving the Missouri River Basin do not, in general, conform to either the hydrologic subbasins or the aggregated subareas (ASA's) established by the U.S. Water Resources Council for water planning purposes. Electric power requirements are more typically gathered and projected on the basis of total systems or groups of coordinated systems. For statistical purposes these areas are tabulated by the Federal Power Commission as power supply areas (PSA's). Eleven such PSA's lie wholly or partially within the Missouri River Basin.

Projected requirements were developed for total PSA's as part of the U.S. Water Resources Council's Second National Water Assessment. The projections were based originally on 1974 and historic information available from individual electric systems but were subsequently modified in mid-1975 during preparation of the National Assessment's Modified Central Case to reflect an approximate 12 percent reduction in total requirements as of the year 2000. The total existing and projected power requirements for the basin, shown in Table 1, were obtained by using the modified central case data and estimating the portion of each PSA within the basin.

Table 1

EXISTING AND PROJECTED ELECTRIC POWER REQUIREMENTS

Year	Peak Demand (MW)	Net Energy Required (GWh)
1975*	17,480	83,400
1985	35,160	169,000
2000	87,600	424,900

*Preliminary

EXISTING ELECTRIC POWER SUPPLY

As of the end of 1974 there were 399 electric generating plants located within the Missouri River Basin with an installed capacity of 21,761 megawatts and net generation capability of 86,107 million kilowatt-hours. Figure 1 shows the location of those generating plants having 25 megawatts or greater installed capacity and the boundaries of the 11 ASA's.

Conventional fossil-fired steam-electric plants, while comprising only 23 percent of the total number of plants, furnished 73 percent of the total electric energy generated. Table 2 gives the 1974 composition of the basin's electric power supply.

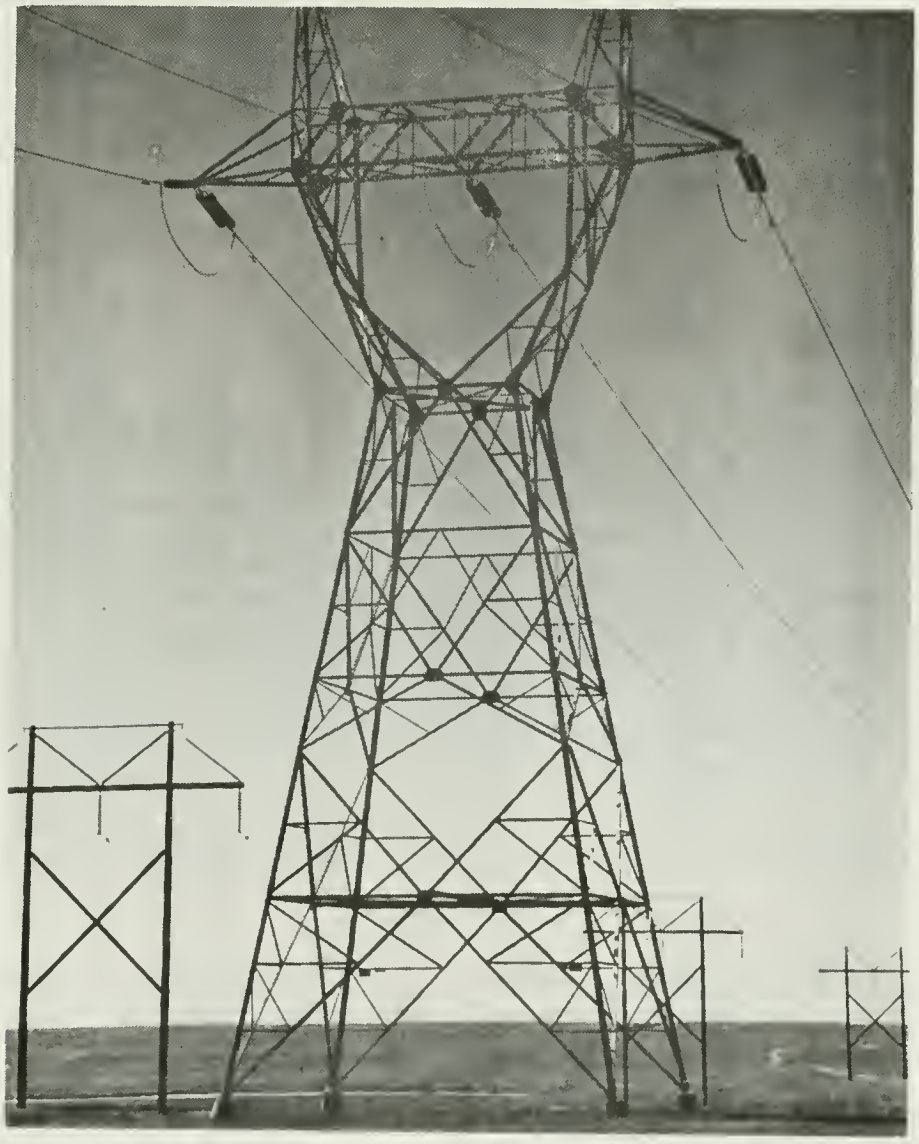
Table 2

EXISTING ELECTRIC POWER SUPPLY

Type Plant	No. of Plants	Installed Capacity (MW)	Net Generation (GWh)
Fossil-Fired Steam	91	14,447	62,482
Nuclear Steam	2	1,282	4,290
Diesel	216	922	1,046
Combustion Turbine	29	1,410	888
Combined Cycle	1	52	29
Conventional Hydro	59	3,348	17,372
Pumped-Storage	1	300	(181) 1/
MRB Total	399	21,761	85,926

1/ Net energy loss because of pumping to upper reservoir.

All of the bulk power supplying systems within the basin are interconnected via an extensive 115-kV, 230-kV, or 345-kV transmission network. Transmission along the western edge of the basin is sparsely located and generally operates below the 230-kV level. Concentrations of both generation and population centers along the eastern edge of the basin have resulted in greater transmission concentrations and higher voltage levels in this area. Figure 1 shows the principal electric transmission lines currently serving the area.



The Bureau of Reclamation's Hayden-Archer (steel towers - foreground) and Archer-Weld (wooden poles - rear) 230 kv transmission lines near the Archer substation. The lines transport electricity from the Colorado River Storage Project, Wyoming.

Fuel Used for Electric Generation

In 1974, conventional steam-electric plants produced 91 percent of the total fossil fuel produced electric energy generated in the basin. Approximately 90 percent of this steam-electric generation was supplied by plants 25 megawatts or larger. Based on an analysis of data reported for 1974, the fuel used by the 25 mw and larger steam plants is summarized in Table 3.

Table 3

1974 FOSSIL FUEL USAGE AT STEAM PLANTS 25 MW OR GREATER

Type Fuel	Quantity Consumed
Coal and Lignite	17,734,000 Tons
Oil	2,009,000 Barrels
Gas	193,512,000 Mcf

Cooling Water Used for Steam-Electric Generation

Fossil-fired and nuclear steam-electric generating plants require large quantities of water for condenser cooling. The quantity of water required at each plant depends on the type of condenser cooling system, the operating efficiency of the plant, permissible temperature rise in the cooling water, and the amount of energy generated. Based on 1974 plant data, 4,211.3 mgd of water were required to be diverted for condenser cooling and 57.4 mgd were lost through heat load induced evaporation. Table 4 summarizes the water use data for each ASA of the Missouri River Basin. Amounts shown are calculated, not measured quantities, based on a plant-by-plant analysis using the annual energy generated, plant heat rate, and type of cooling system employed.

ANTS – 25 MW OR GREATER
ECEMBER 31, 1974

FIGURE 1

acity	Plant No.	Utility	Plant Name	Capacity
35	59	OMPP	Sarpy	110
48	60	CEIC	Summit Lake	52
48	61	NEPP	Cooper	800
45	62	SAJL	Edmond Street	43
38	63	SAJL	Lake Road	St 151
50				Ct 70
172	64	CETU	Clifton	85
69	65	CEKP	Ross Beach	37
250	66	KAPL	Abilene	St 34
165				Ct 78
50	67	KAPL	Tecumseh	St 346
400				Ct 53
172	68	KAPL	Lawrence	613
240	69	KACY	Quindaro	St 334
256				Ct 82
100	70	KACP	Hawthorn	908
595	71	NOEP	Missouri City	40
468	72	INDN	Jackson Station	95
320	73	MIPU	Sibley	519
48	74	INDN	Blue Valley	115
75	75	MIPU	Ralph Green	50
37	76	KACP	Northeast	St 133
31				Ct 101
34	77	KACP	Grand Avenue	127
27	78	KACY	Kaw Station	161
787	79	KAGE	LaCygne	828
36	80	KACP	Montrose	563
48	81	MARS	Marshall	27
36	82	ASEC	Thomas Hill	470
32	83	COLM	Columbia	107
45	84	CEEP	Chamois	59
33	85	MILC	Jefferson City	62
72	86	UNEC	Osage	176
282	87	USAR	Stockton	45
66	88	SPRM	James River	257
300	89	NEPP	Columbus	39
251	90	MIPU	Nevada	29
115				
801				
101				
39				
26				

MAJOR ELECTRIC FACILITIES WITHIN THE MISSOURI RIVER BASIN

FEDERAL POWER COMMISSION

CHICAGO REGIONAL OFFICE

APRIL 1976

LEGEND

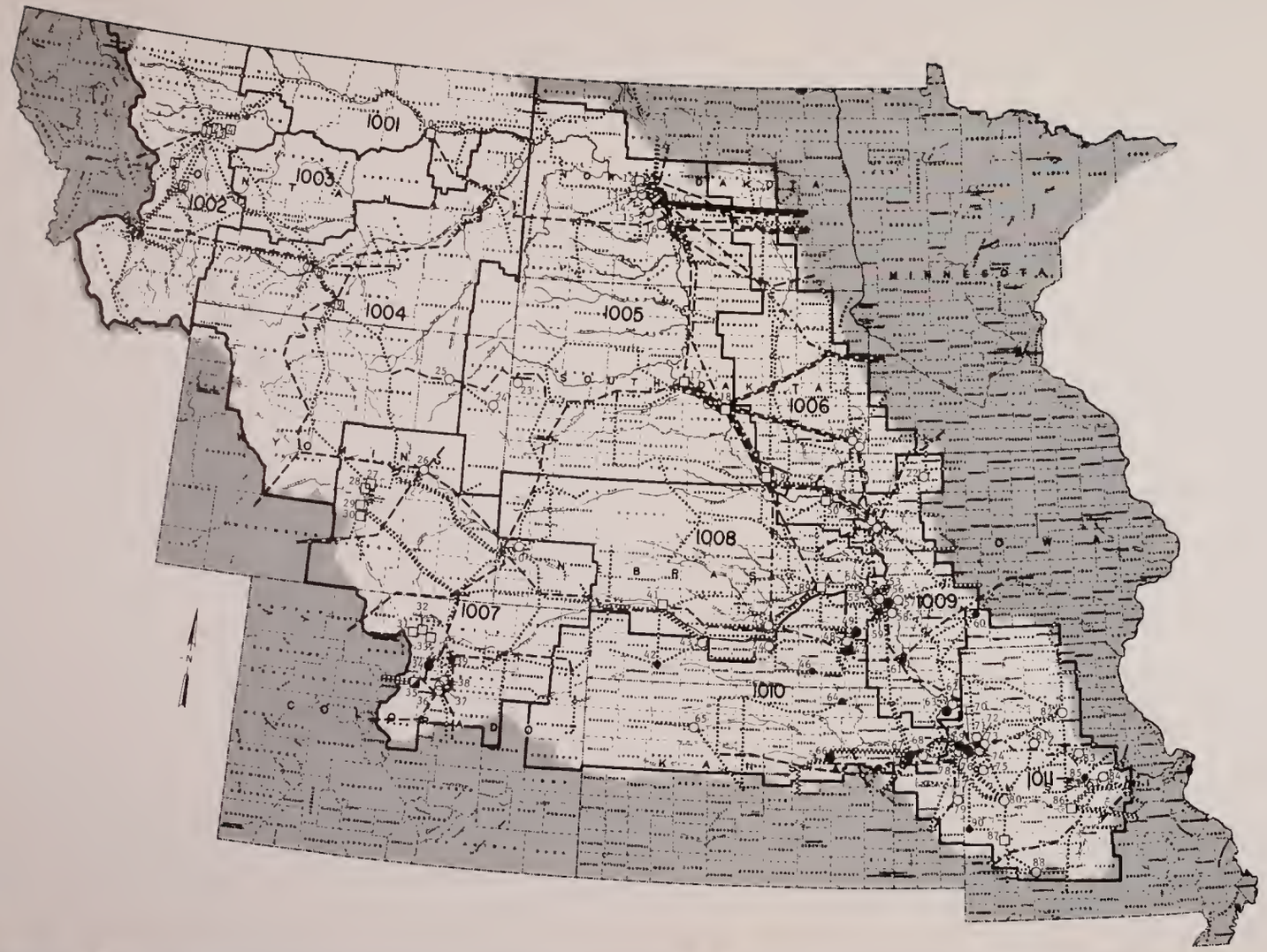
TRANSMISSION LINES	GENERATING PLANTS
····· 100-161 KV	● Combustion Turbine
— — — 230 KV	○ Steam
- · — · - 345 KV	⊛ Nuclear
±250 KVDC	□ Hydro
	◪ Pumped Storage

1002 AGGRAGATED SUBAREA

NOTE: TRANSMISSION LINE ROUTINGS ARE GENERALIZED.

UTILITY CODE

ASEC–ASSOCIATED ELECTRIC COOP.
BAEP–BASIN ELECTRIC POWER COOP.
BLHP–BLACK HILLS POWER AND LIGHT CO.
CEEP–CENTRAL ELECTRIC POWER COOP.
CEIC–CENTRAL IOWA POWER COOP.
CEKP–CENTRAL KANSAS POWER CO.
CETU–CENTRAL TELEPHONE AND UTILITIES CORP.
COBP–CORN BELT POWER COOP.
COLM–COLUMBIA
FREM–FREMONT
GRIS–GRAND ISLAND
HAST–HASTINGS
INDN–INDEPENDENCE
IOPL–IOWA POWER AND LIGHT CO.
IOPS–IOWA PUBLIC SERVICE CO.
KACP–KANSAS CITY POWER AND LIGHT CO.
KACY–KANSAS CITY
KAGE–KANSAS GAS AND ELECTRIC CO.
KAPL–KANSAS POWER AND LIGHT CO.
MARS–MARSHALL
MILC–MISSOURI POWER AND LIGHT CO.
MIPI–MINNKOTA POWER COOP., INC.
MIPU–MISSOURI PUBLIC SERVICE CO.
MODU–MONTANA-DAKOTA UTILITIES CO.
MOPO–MONTANA POWER CO.
NEPP–NEBRASKA PUBLIC POWER DISTRICT
NOEP–N.W. ELECTRIC POWER COOP., INC.
NOSM–NORTHERN STATES POWER CO.
OMPP–OMAHA PUBLIC POWER DISTRICT
PAPL–PACIFIC POWER AND LIGHT CO.
PSCO–PUBLIC SERVICE CO. OF COLORADO
SAJL–ST.JOSEPH LIGHT AND POWER CO.
SPRM–SPRINGFIELD
UNEC–UNION ELECTRIC CO.
UNPA–UNITED POWER ASSOCIATION
USAR–U.S. ARMY
USBR–U.S. BUREAU OF RECLAMATION



GENERATING PLANTS – 25 MW OR GREATER
AS OF DECEMBER 31, 1974

Plant No.	Utility	Plant Name	Capacity
1	MOPO	Rainbow	35
2	MOPO	Cochrane	48
3	MOPO	Ryan	48
4	MOPO	Morony	45
5	MOPO	Holter	38
6	USBR	Canyon Ferry	50
7	MOPO	J. E. Corette	172
8	MOPO	Frank Bird	69
9	USBR	Yellowtail	250
10	USBR	Ft. Peck	165
11	MODU	Lewis & Clark	50
12	USBR	Garrison	400
13	UNPA	Stanton	172
14	BAEP	Leland Olds	240
15	MIPI	M. L. Young	256
16	MODU	R. M. Heskett	100
17	USBR	Oahe	595
18	USBR	Big Bend	468
19	USBR	Ft. Randall	320
20	NOSM	Lawrence	48
21	NOSM	Pathfinder	75
22	COBP	E. F. Wiscon	37
23	BLHP	Kirk	31
24	BLHP	Osage	34
25	BLHP	Neil Simpson	27
26	PAPL	Johnston	787
27	USBR	Alcova	36
28	USBR	Fremont	48
29	USBR	Kortes	36
30	USBR	Seminoe	32
31	USBR	Estes	45
32	USBR	Pole Hill	33
33	USBR	Flatiron	72
34	PSCO	Valmont	St 282 Ct 66
35	PSCO	Cabin Creek	300
36	PSCO	Arapahoe	251
37	PSCO	Zuni	115
38	PSCO	Cherokee	801
39	PSCO	Ft. Lupton	101
40	NEPP	Bluffs	39
41	NEPP	North Platte	26
42	NEPP	McCook	36
43	NEPP	Canaday	108
44	HAST	North Denver	50
45	GRIS	C. W. Burdick	93
46	NEPP	Hebron	38
47	NEPP	Hallam	38
48	NEPP	Sheldon	228
49	NEPP	Lincoln	St 31 Ct 31
50	USBR	Gavins Point	100
51	IOPS	Big Sioux	41
52	IOPS	George Neal	496
53	OMPP	Ft. Calhoun	481
54	FREM	Fremont	43
55	OMPP	North Omaha	644
56	OMPP	Jones Street	St 83 Ct 130
57	IOPL	Council Bluffs	130
58	NEPP	Kramer	112
59	OMPP	Sarpy	110
60	CEIC	Summit Lake	52
61	NEPP	Cooper	800
62	SAJL	Edmond Street	43
63	SAJL	Lake Road	St 151 Ct 70
64	CETU	Clifton	86
65	CEKP	Ross Beach	37
66	KAPL	Abilene	St 34 Ct 78
67	KAPL	Tecumseh	St 346 Ct 53
68	KAPL	Lawrence	613
69	KACY	Quindaro	St 334 Ct 82
70	KACP	Hawthorn	908
71	NOEP	Missouri City	40
72	INDN	Jackson Station	95
73	MIPU	Sibley	519
74	INDN	Blue Valley	115
75	MIPU	Ralph Green	50
76	KACP	Northeast	St 133 Ct 101
77	KACP	Grand Avenue	127
78	KACY	Kaw Station	161
79	KAGE	LaCygne	828
80	KACP	Montrose	563
81	MARS	Marshall	27
82	ASEC	Thomas Hill	470
83	COLM	Columbia	107
84	CEEP	Chamois	59
85	MILC	Jefferson City	62
86	UNEC	Osage	176
87	USAR	Stockton	45
88	SPRM	James River	257
89	NEPP	Columbus	39
90	MIPU	Nevada	29

FIGURE 1

MAJOR ELECTRIC FACILITIES WITHIN THE MISSOURI RIVER BASIN

FEDERAL POWER COMMISSION
CHICAGO REGIONAL OFFICE
APRIL 1976

LEGEND

TRANSMISSION LINES	GENERATING PLANTS
····· 100-161 KV	● Combustion Turbine
— — — 230 KV	○ Steam
-·-·- 345 KV	⊛ Nuclear
——— ±250 KVDC	□ Hydro
	◪ Pumped Storage

1002 AGGREGATED SUBAREA

NOTE: TRANSMISSION LINE ROUTINGS ARE GENERALIZED.

UTILITY CODE

ASEC–ASSOCIATED ELECTRIC COOP.
BAEP–BASIN ELECTRIC POWER COOP.
BLHP–BLACK HILLS POWER AND LIGHT CO.
CEEP–CENTRAL ELECTRIC POWER COOP.
CEIC–CENTRAL IOWA POWER COOP.
CEKP–CENTRAL KANSAS POWER CO.
CETU–CENTRAL TELEPHONE AND UTILITIES CORP.
COBP–CORN BELT POWER COOP.
COLM–COLUMBIA
FREM–FREMONT
GRIS–GRAND ISLAND
HAST–HASTINGS
INDN–INDEPENDENCE
IOPL–IOWA POWER AND LIGHT CO.
IOPS–IOWA PUBLIC SERVICE CO.
KACP–KANSAS CITY POWER AND LIGHT CO.
KACY–KANSAS CITY
KAGE–KANSAS GAS AND ELECTRIC CO.
KAPL–KANSAS POWER AND LIGHT CO.
MARS–MARSHALL
MILC–MISSOURI POWER AND LIGHT CO.
MIPI–MINNKOTA POWER COOP., INC.
MIPU–MISSOURI PUBLIC SERVICE CO.
MODU–MONTANA-DAKOTA UTILITIES CO.
MOPO–MONTANA POWER CO.
NEPP–NEBRASKA PUBLIC POWER DISTRICT
NOEP–N.W. ELECTRIC POWER COOP., INC.
NOSM–NORTHERN STATES POWER CO.
OMPP–OMAHA PUBLIC POWER DISTRICT
PAPL–PACIFIC POWER AND LIGHT CO.
PSCO–PUBLIC SERVICE CO. OF COLORADO
SAJL–ST.JOSEPH LIGHT AND POWER CO.
SPRM–SPRINGFIELD
UNEC–UNION ELECTRIC CO.
UNPA–UNITED POWER ASSOCIATION
USAR–U.S. ARMY
USBR–U.S. BUREAU OF RECLAMATION

Table 4

STEAM-ELECTRIC COOLING WATER USE IN THE MISSOURI RIVER BASIN

ASA	Net Generation (GWh)	Water Diverted (mgd)	Evaporative Loss (mgd)
1001	-	-	-
1002	-	-	-
1003	-	-	-
1004	1,479	163.9	1.7
1005	5,801	530.6	7.4
1006	297	13.9	0.7
1007	12,038	443.3	12.5
1008	1,613	97.3	2.8
1009	13,246	1,970.2	13.2
1010	4,821	150.1	5.8
1011	16,772	842.0	13.3
TOTAL	56,067	4,211.3	57.4

In areas with insufficient water to support even the limited requirements of either wet cooling towers or cooling ponds, air-cooled, dry type cooling towers may be used. The 330 MW Wyodak plant now being built jointly by Black Hills Power and Light Company and Pacific Power and Light Company at Wyodak, Wyoming, will be the largest air-cooled electric generating plant in the world. Dry type cooling towers are, however, the most costly to construct and also the most costly to operate of all the types of cooling systems. Because of these costs, very few of this type have been built, and very few are currently planned.

Utilization rates for determining typical water usage for once-through, cooling pond, and cooling tower type cooling systems were developed for use in the U.S. Water Resources Council's Second National Water Assessment. Table 5 shows the usage rates based on a typical 1975 plant of 1,000 megawatts when operated at 100 percent plant factor. For lesser plant factors the usage rates would be reduced proportionately.

Table 4

STEAM-ELECTRIC COOLING WATER USE IN THE MISSOURI RIVER BASIN

ASA	Net Generation (GWh)	Water Diverted (mgd)	Evaporative Loss (mgd)
1001	-	-	-
1002	-	-	-
1003	-	-	-
1004	1,479	163.9	1.7
1005	5,801	530.6	7.4
1006	297	13.9	0.7
1007	12,038	443.3	12.5
1008	1,613	97.3	2.8
1009	13,246	1,970.2	13.2
1010	4,821	150.1	5.8
1011	16,772	842.0	13.3
TOTAL	56,067	4,211.3	57.4

In areas with insufficient water to support even the limited requirements of either wet cooling towers or cooling ponds, air-cooled, dry type cooling towers may be used. The 330 MW Wyodak plant now being built jointly by Black Hills Power and Light Company and Pacific Power and Light Company at Wyodak, Wyoming, will be the largest air-cooled electric generating plant in the world. Dry type cooling towers are, however, the most costly to construct and also the most costly to operate of all the types of cooling systems. Because of these costs, very few of this type have been built, and very few are currently planned.

Utilization rates for determining typical water usage for once-through, cooling pond, and cooling tower type cooling systems were developed for use in the U.S. Water Resources Council's Second National Water Assessment. Table 5 shows the usage rates based on a typical 1975 plant of 1,000 megawatts when operated at 100 percent plant factor. For lesser plant factors the usage rates would be reduced proportionately.

Table 5

WATER USE RATES FOR 1000 MW STEAM-ELECTRIC PLANT
(Operating at 100% Plant Factor)

	Once-Through		Cooling Pond		Cooling Tower	
	Nuclear	Fossil	Nuclear	Fossil	Nuclear	Fossil
Plant Heat Rate, Btu/KWh	10,500	8,800	10,500	8,800	10,500	8,800
Condenser Flow[a], mgd	1,450	899	1,047	649	785	487
Withdrawal, mgd	1,450	899	18	11	27	17
Return Flow, mgd	1,450	899	6	4	9	6
Consumption, mgd	9[b]	6[b]	12	7	18	11

a/ Based on an assumed temperature rise of 13° F for once-through, 18° F for cooling pond, and 24° F for cooling tower.

b/ Evaporation losses which take place after heated cooling water is returned to source.

Electric Plant Construction and Operating Costs

The mix of electric generating plant types is governed by a number of factors. Two of the most important of these factors are the initial cost to construct a particular type plant and the annual cost to operate the plant. It is typically true that if a particular plant has a high initial cost to build, it will also have a relatively low annual operating cost. Conversely, if the initial cost of a plant is low, it will have a relatively high annual operating cost. Within the Missouri River Basin, the whole range of capacity types are being built. These include nuclear, conventional steam plants fueled by coal or lignite, combustion turbines, conventional hydro, and pumped-storage hydro.

Nuclear. Nuclear plants are among the most costly to build. At the end of 1974, only two such plants were operating in the basin. The Omaha Public Power District and Nebraska Public Power District both placed new nuclear units into service in 1973. The reported average cost of these two units was $329 per kilowatt. Since these two nuclear plants were placed in service, costs have continued to escalate; it is estimated that the current cost in 1976 dollars to build a typical two-unit nuclear plant would be $439 per kilowatt. Approximately 7½ years are required to construct a typical two-unit nuclear plant. In addition, substantial delays may be encountered during the regulatory review and licensing process.

The Fort Calhoun Nuclear Power Plant, a single reactor 455 MW facility, is located between Omaha and Blair, Nebraska, on the Missouri River. The plant is owned and operated by the Omaha Public Power District.

During 1974 the two Nebraska nuclear units generated more than 4,289 million kilowatt-hours at a total production cost of about $13.8 million. This is equivalent to a per unit production cost of 3.2 mills per kilowatt-hour.

Conventional Steam. Steam plants operating on fossil fuels are the primary source of baseload generation in the basin. During the period 1970-1974, 4,463 megawatts of this type capacity were added at nine sites. It is estimated that the cost of adding this new capacity was about $186 per kilowatt and that its average 1974 production cost was 4.7 mills per kilowatt-hour.

Because of continuing cost increases, the estimated cost of a similar type two-unit coal-fired plant in 1976 was $339 per kilowatt. This did not include the cost of any required sulfur dioxide removal equipment.

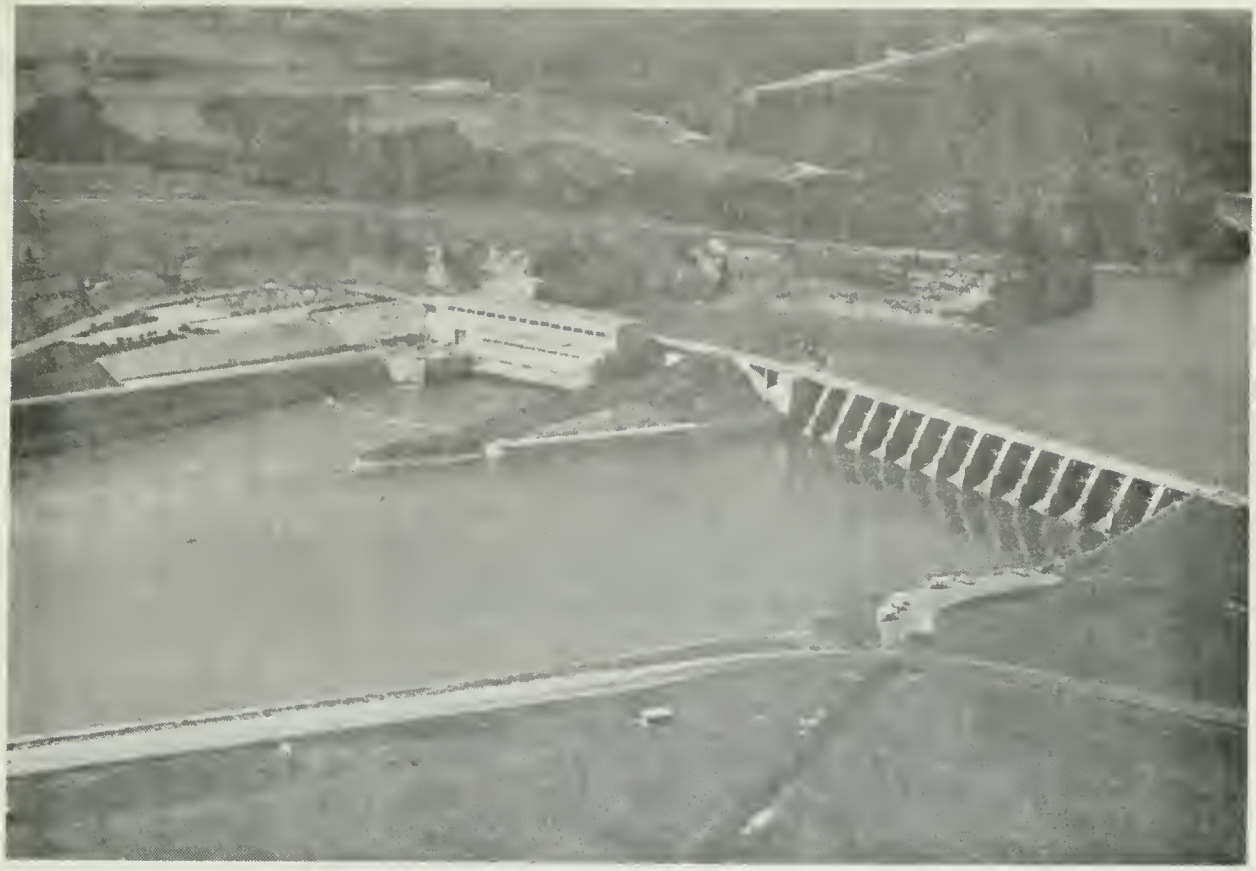
Since approximately 5½ years are required to construct a typical two-unit fossil-fired steam plant, the 1976 production estimate does not adequately reflect elevated costs resulting from installation delays. In addition, substantial postponements contributing to increased costs may result from siting and other regulatory review procedures.

Comparable size lignite-fueled plants, on the other hand, are generally more costly to construct and operate than conventional coal-fired plants. The higher cost for a lignite plant results from the need to install larger boilers and more extensive fuel handling equipment required to accommodate larger fuel consumption rates. The estimated 1976 cost of a lignite-fueled plant was $390 per kilowatt.

The annual production cost for coal- or lignite-fueled plants is largely dependent on the cost of the fuel being burned. Typical current values for new plants are 5.6 mills per kilowatt-hour for coal plants and 2.4 mills per kilowatt-hour for lignite plants.

Combustion turbine plants are among the least expensive to build. These plants are largely standardized in design and can be placed in service in a relatively short time. The present cost of installing units of this type is estimated to be about $125 per kilowatt. Although low in initial cost, combustion turbines are among the most costly to operate and are therefore generally limited to peaking type operation. Either natural gas or No. 2 fuel oil can be used to fuel combustion turbines. Because of the growing shortage of natural gas, fuel oil must be assumed to be the more typical fuel. At today's oil cost, the production cost for combustion turbine plants can approach 35 mills per kilowatt-hour.

Hydroelectric. The cost of installing and the period to construct conventional hydro-electric capacity varies significantly from project to project depending on the unique physical features at each site. The feasibility of developing a particular site and operating a hydro facility is therefore gaged against the cost of developing and operating the least costly alternative plant.



The Missouri River's Gavins Point Dam. Located in South Dakota, this multiple-purpose reservoir has an installed power capacity of 100,000 kw.

Presently, there is only one pumped-storage plant located in the basin, the 300 megawatt Cabin Creek plant operated by Public Service Company of Colorado. The Cabin Creek project was placed in service during 1966-1967 at an average cost of $113 per kilowatt. As in the case of conventional hydroelectric projects, physical features of a particular site can significantly influence the project cost and the construction period. A recently constructed 2,000 megawatt pumped storage project located in the State of Michigan was built at a cost of $154 per kilowatt.

Because not all of the pumping energy can be recovered by releasing the water stored in the upper reservoirs, production costs for pumped-storage plants are largely the result of costs incurred for the pumping energy used in refilling the upper reservoir. While the actual recoverable energy varies depending on the design of a particular project, a rule-of-thumb estimate gives two kilowatt-hours of generation for each three kilowatt-hours of pumping energy.

Pumped-storage plants are typically refilled during evening or weekend periods when reduced system loads allow otherwise idle baseload plants to generate the necessary pumping energy. Nuclear generation or fossil-fueled steam generation will generally be used where not already fully loaded during off peak periods. On systems where this capacity is already fully utilized, the lowest production cost units not already loaded will be selected. Because of the three to two pumping to generation ratio, the effective fuel cost of a pumped-storage plant is approximately 1½ times greater than the incremental cost of the pumping source.

ENVIRONMENTAL CONTROL FACILITIES

In the past, establishment of legitimate environmental concerns raised questions that resulted in strict environmental controls for power generating plants. The compliance costs resulting from these controls are high, and the technology required to solve all environmental problems is still developing. Presently, the control of plant emissions to air and water are of major concern.

Air Emission Control Facilities

The primary environmental concern associated with air emissions from electric power plants relates to the discharge of particulate and gaseous matter into the atmosphere. The problem of particulate emissions from stacks of coal/ lignite fueled electric plants is being largely solved by the installation of mechanical collectors and electrostatic precipitators. These devices remove between 97 and 99 percent of all particulate emissions.

Gaseous emissions, largely in the form of sulfur oxides, pose a considerably greater problem. Various systems which are designed to remove a portion of this emission are now undergoing prototype testing. However, none of these systems have operated for extended periods on large baseload units. It is generally agreed that sulfur dioxide removal systems, when perfected and installed, will result in a significant increase in the cost of constructing a coal or lignite fueled electric plant. It is estimated that the installation of a sulfur dioxide removal system on a typical two unit plant will ad $75 per kilowatt to the total plant cost. At a typical plant this represents about $100 million (roughly 20 percent) in added construction costs.

Thermal Discharge Control Facilities

All conventional steam and nuclear generating plants require the dissipation of large quantities of waste heat. Once-through cooling continues to be the most common type system at existing generating facilities. These systems withdraw water from either a lake or a stream, pass the water through the plant's condensing system where the waste heat load is absorbed, and then discharge the heated water back to the original water source. With the imposition of thermal discharge standards, and as the number of sites capable of supporting

large generating plants become more scarce, alternate types of cooling systems are being utilized.

Wet cooling towers and cooling ponds are the most common types of alternate systems. Both are more costly to install and to operate than a once-through system. Each, however, has the advantage of eliminating, or greatly reducing, the waste heat load imposed on the water supply source. In addition, each is essentially a closed system; such systems require the withdrawal of only enough water to replace the evaporative losses within the system and to allow for sufficient dilution of the circulating water to maintain dissolved solids buildup within acceptable limits.

Two types of water cooling systems are shown in this picture of the St. Vrain Nuclear Plant at Greeley, Colorado. A cooling pond is shown in the foreground, and a series of wet cooling towers is pictured on the left.

ACTUAL FOSSIL FUEL COSTS FOR ELECTRIC GENERATING PLANTS

The Federal Power Commission issues monthly reports of fuel costs summarized by major geographic areas. These data include all fossil-fueled electric plants with a total combined steam-electric, combustion turbine, and internal combustion generating capacity of 25 megawatts or greater. Average costs during the period November 1974 through October 1975 for the West North Central Region consisting of Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota are given in Table 6.

Table 6

ELECTRIC GENERATING PLANT FUEL COSTS

Type Plant	Type of Fuel			
	Coal	Oil	Gas	Nuclear
	(cents per million natural Btu)			
Steam-electric	59.3	179.1	53.9	25.0
Combustion Turbine and Internal Combustion	-	208.8	55.0	-

CHAPTER 3. POWER RESOURCES FOR FUTURE DEVELOPMENT

This chapter deals with nationwide projections of growth in total energy needs and of electrical generation from the base year of 1973 to 2000. In addition, it contains a tabulation of planned changes in generating capacity proposed by utilities serving the Missouri River Basin and a listing of those additions to main stem hydro-power currently under active study by the Corps of Engineers.

The additional main stem units reflect those best suited for construction within the next decade. By the turn of the century, additional pumped-storage units adjacent to Garrison Reservoir may be warranted, as well as three more hydro-power units at the Oahe power installation and one more at Fort Peck, Montana.

TOTAL ENERGY, ELECTRIC ENERGY, AND NUCLEAR POWER PROJECTIONS FOR THE UNITED STATES--1975

The Energy Research and Development Administration (ERDA), through its Office of Planning and Analysis, prepared in early 1975 new projections of energy, electric power, and nuclear power demand and supply for the United States through the year 2000. These estimates update the forecasts published in "Nuclear Power Growth, 1974-2000," WASH-1139(74) prepared in February 1974.

The future energy patterns contained in WASH-1139(74) were developed prior to establishment of the Energy Research and Development Administration and did not specifically include research and development (R&D) activities now being vigorously pursued by ERDA. Revised forecast material to include new technologies based on objectives and programs established in the updated energy R&D plan was to be prepared by mid-1976.

The total energy and electric power projections are derived through the use of econometric analyses and energy network flows. The econometric work relates population, employment, and productivity factors to project Gross National Product (GNP). Total energy resource consumption and energy inputs to the electrical sector are then related to GNP growth to provide aggregate values for guiding the more detailed fuel substitution possibilities. The energy network system, developed by Brookhaven National Laboratory, permits adjustments in analyzing changes in final sector demands and relative efficiencies of energy delivery systems to generate fuel substitution patterns and related energy inputs.

Total Energy Patterns

Three total energy cases are developed in the 1975 report. These correspond to the energy projections used in Cases A, D, and B in the previous 1974 forecast. Comparison with Project Independence projections shows that previous estimates are still valid. However, the proportion

of energy in the electric sector has changed. Table 7 shows total energy projections for each case to the year 2000.

High Case - This is based on continuation of past economic-energy relationships and generally continues an historic growth pattern without emphasis on energy conservation.

Growth rates: 1973-1985 - 3.7% per annum

1986-2000 - 3.5% per annum

(Note: Growth rates are computations after scenario development rather than pre-determined values.)

Moderate Case - This reflects a reasonable expectation of conservation and improved efficiency of energy use, but these measures are not so stringent as to limit improvements in standard of living or economic development; the response to increased energy prices is to continue to meet basic energy demands by more efficient means.

Growth rates: 1973-1985 - 2.75% per annum

1986-2000 - 3.45% per annum

Low Case - This depicts a slower rate of economic growth due to higher energy prices relative to other commodities and decreased emphasis on production of goods; maximum efforts are made to conserve energy by increasing utilization efficiencies in all sectors.

Growth rates: 1973-1985 - 2.0% per annum

1986-2000 - 2.3% per annum

Table 7

TOTAL ENERGY PROJECTIONS
(10^{15} BTU)

Case	1973	1980	1985	1990	2000
High	75.6	95.3	116.6	136.8	195.0
Moderate	75.6	89.7	104.8	122.6	174.3
Low	75.6	86.1	96.2	107.9	135.3

Electric Energy Patterns

In 1973, electric energy represented 26 percent of the total energy inputs. In 1974, kilowatt hours of electrical production remained the same as in 1973. Expectations for 1975 per annum growth, however, range from 3 percent to 6 percent.

Electric energy production futures were developed in relation to the total energy cases with a high projection, a low projection, and two projections within the framework of the moderate energy case. Table 8 shows the projected electricity production growth to the year 2000 for each growth rate.

High Case - Electricity production resumes growth near the historic rate of 7 percent per annum through the middle 1980's, then declines to a 6.4 percent per annum growth through the end of the century. Electric energy inputs increase to 50 percent of total resource consumption by 2000.

Moderate/High Case - This postulates that within the moderate energy case, while rising electricity prices cause reductions in expected future demands, the availability and prices of other fuels are such as to cause continuing substitution of electric energy for direct energy uses. Kilowatt-hour production grows at a 6.25 percent per annum rate through 1985 and at a 5.85 percent per annum rate through the last 15 years of the century.

Moderate/Low Case - Within the moderate energy case, the substitution of electric energy for direct energy use occurs at a more modest rate, reflecting that relative prices for electricity are not so advantageous and that other fuels are more readily available. Kilowatt-hour production grows at 6.0 percent per annum through 1985 then declines to a 5.4 percent per annum growth through 2000.

Low Case - The stringent conservation measures in the total energy situation specified within this case are combined with an electric energy situation that continues to capture an increasingly larger portion of final demands. While kilowatt-hour growth is only 5.8 percent through 1985 and an even lower 4.75 percent for the latter part of the century, electric energy inputs rise to account for 51 percent of total energy inputs.

Table 8

PROJECTED ELECTRICITY PRODUCTION GROWTH
(Billion kilowatt-hours)

Growth Rate	1973	1980	1985	1990	2000
High	1,878	2,780	3,905	5,290	9,880
Moderate/High	1,878	2,675	3,660	4,820	8,600
Moderate/Low	1,878	2,630	3,570	4,660	7,925
Low	1,878	2,570	3,500	4,400	7,020

Total Electrical Capacity

The total installed electric generating capacity is affected by the electric system capacity factor and the average heat rate for the plants. Table 9 shows projections of generating capacity based on the following assumptions concerning the capacity factor and the heat rate.

System Capacity Factor - (1) A low capacity factor will prevail for the next few years due to utility additions of nearly completed plants in 1974-75; during which time, peak load demand experienced only a small growth. (2) Long-term improvement in system factors reflects modest introduction of peak pricing schemes and/or more effective use of energy storage devices.

Heat Rates - (1) Current U.S. Average is approximately 10,500 BTU/KWH. (2) Inclusion of cooling towers, sulfur removal equipment, and other environmental control systems will offset technological advances in power plant efficiency, thus preventing large decreases in average heat rate in the near term. (3) Nuclear plants, with 40 percent thermal efficiency, will cause some decrease in heat rate averages. (4) As newer plants are installed and older plants retired, the heat rate average will decline to 10,000 BTU/KWH by 1990 and 9,800 by the end of the century. (5) The use of combined cycle fossil plants with 45 percent to 50 percent thermal efficiencies have not been included in the heat rate assessment.

Table 9

PROJECTED TOTAL ELECTRIC GENERATING CAPACITY
(GW)

	1973	1980	1985	1990	2000
High	436.0	655.0	875.0	1,180.0	2,180.0
Moderate/High	436.0	630.0	820.0	1,075.0	1,900.0
Moderate/Low	436.0	620.0	800.0	1,040.0	1,750.0
Low	436.0	605.0	785.0	980.0	1,550.0

Nuclear Energy Projections

Four forecast cases corresponding to the four electric energy situations have been prepared.

High Case - This case reflects the Presidential objectives for 200 new nuclear power plants through 1985 and a continuation of a concerted nuclear effort in the longer term and is coupled with continued high rates of growth in electric energy. For 1985, this case would require that all plants maintain currently announced

operation date schedules and that an additional 30,000 MW be scheduled for installation in the same period.

Moderate/High Case - This case is primarily based on the number of plants ordered in the short run with some allowance for additional slippage in schedules. The longer-term presumes that nuclear power plants maintain an economic advantage over other type central station power plants and therefore capture the largest portion of new additions.

Moderate/Low Case - Within a setting of slower growth of electrical usage, the need for new central station plants is reduced, and consequently, a similar type reduction in nuclear power plants is experienced. While nuclear power maintains an economic advantage, the problems of high capital costs and long lead times cause some shifting to fossil-fueled plants.

Low Case - Associated with low total and electric energy scenarios, a low nuclear growth case is postulated. The case presumes that in the short term, nuclear power plants continue to be plagued by numerous problems creating large slippages in announced schedules. During the long term, nuclear power plants are presumed to have only a marginal economic advantage over new technology fossil-fuel plants.

Table 10

PROJECTED INSTALLED NUCLEAR CAPACITY
(GW)

	1973	1980	1985	1990	2000
High	18.4	92.0	245.0	470.0	1,250.0
Moderate/High	18.4	82.0	205.0	385.0	1,000.0
Moderate/Low	18.4	76.0	185.0	340.0	800.0
Low	18.4	70.5	160.0	285.0	625.0

PRESENT AND PLANNED GENERATING CAPACITY

At present there is approximately 21,761 MW of installed electrical generating capacity in the Missouri River Basin. Projections of future electric power generation needs are shown in Table 11.

Table 11

FUTURE ELECTRIC POWER DEMAND

Year	Peak Demand (MW)
1975	17,480
1985	35,160
2000	87,600

Scheduled or planned additional generating capacity is shown in Table 12. This includes only the additional capacity that is planned to be in service by 1984. Table 13 shows the potential for additional hydro-power generating capacity on Missouri River main stem reservoirs and for pumped storage at Fort Randall Reservoir.

Table 12

SCHEDULED OR PLANNED ADDITIONAL GENERATING CAPACITY

Plant Name	Capacity (MW)	Type	In-Service (Year)	Location		
				State	County	Subbasin
Fort St. Vrain	330	NU	1976	CO	Weld	Platte-Niobrara
Pawnee	1,000	ST	1981	CO	Morgan	Platte-Niobrara
Burlington	135	CT	1977	CO	Kit Carson	Kansas
Co. Bluffs	650	ST	1979	IA	Pottawattamie	Middle Missouri
Geo. Neal	550	ST	1976	IA	Woodbury	Middle Missouri
Geo. Neal	585	ST	1979	IA	Woodbury	Middle Missouri
Jeffrey	720	ST	1978	KS	Pottawatomie	Kansas
Jeffrey	720	ST	1980	KS	Pottawatomie	Kansas
Jeffrey	720	ST	1982	KS	Pottawatomie	Kansas
Jeffrey	720	ST	1984	KS	Pottawatomie	Kansas
LaCygne	630	ST	1977	KS	Linn	Lower Missouri
Nearman	235	ST	1979	KS	Wyandotte	Kansas
Nearman	320	ST	1982	KS	Wyandotte	Kansas
Iatan	630	ST	1980	MO	Platte	Middle Missouri
Northeast	116	CT	1976	MO	Jackson	Lower Missouri
Riverside	100	CT	1979	MO	Jackson	Lower Missouri
Southwest	200	ST	1976	MO	Greene	Lower Missouri
Southwest	200	ST	1981	MO	Greene	Lower Missouri
Southwest	55	CT	1979	MO	Greene	Lower Missouri
Greenwood	58	CT	1977	MO	Dade	Lower Missouri
Greenwood	58	CT	1979	MO	Dade	Lower Missouri
Callaway	1,200	NU	1981	MO	Callaway	Lower Missouri
Callaway	1,200	NU	1983	MO	Callaway	Lower Missouri
H. S. Truman	160	HY	1980	MO	Benton	Lower Missouri

Table 12 (con't.)

Plant Name	Capacity (MW)	Type	In-Service (Year)	Location		
				State	County	Subbasin
Colstrip	330	ST	1976	MT	Rosebud	Yellowstone
Colstrip	700	ST	1979	MT	Rosebud	Yellowstone
Colstrip	700	ST	1980	MT	Rosebud	Yellowstone
Gentleman	650	ST	1978	NE	Lincoln	Platte-Niobrara
Gentleman	600	ST	1980	NE	Lincoln	Platte-Niobrara
Nebraska City	575	ST	1979	NE	Otoe	Middle-Missouri
Fremont	91	ST	1976	NE	Dodge	Platte-Niobrara
Ft. Calhoun	1,150	NU	1983	NE	Washington	Middle-Missouri
Milton Young	430	ST	1977	ND	Oliver	Western Dakota
Beulah	400	ST	1982	ND	Mercer	Western Dakota
Jamestown	30	CT	1976	ND	Stutsman	Eastern Dakota
Jamestown	30	CT	1978	ND	Stutsman	Eastern Dakota
Coal Creek	500	ST	1978	ND	McLean	Western Dakota
Coal Creek	500	ST	1979	ND	McLean	Western Dakota
Aberdeen	25	CT	1978	SD	Brown	Eastern Dakota
Mitchell	25	CT	1979	SD	Davison	Eastern Dakota
Huron	25	CT	1980	SD	Beadle	Eastern Dakota
Laramie River	500	ST	1980	WY	Platte	Platte-Niobrara
Laramie River	500	ST	1981	WY	Platte	Platte-Niobrara
Laramie River	500	ST	1983	WY	Platte	Platte-Niobrara
Wyodak	330	ST	1978	WY	Campbell	Western Dakota
TOTAL	20,283					

NOTE: The State of Minnesota has no major generation capacity planned in the Missouri River Basin.

ST = Steam
CT = Combustion Turbine
NU = Nuclear
HY = Hydro-electric

Table 13

ADDITIONAL HYDRO-POWER POTENTIAL

Item	Fort Peck	Garrison	Fort Randall	Total Main Stem	Pumped Storage Fort Randall Gregory County
Number of Units	1	3	4	8	3
Installed Capacity (MW)	100	272	282	646.5	1,180
Dependable Capacity (MW)	92.5	220	250	570	1,080
Construction Period (yrs.)	3	3	4½		4
In Service Date	1986	1986	1988		1986
Gross Head (ft.)	168	146	112		711
Approx. Discharge for Rated Capacity (cfs)					24,700
Existing Plus Potential Units	23,900	70,300	82,000		
Existing Units	15,200	40,000	45,000		

Comparing the total installed and planned generating capacity of 42,044 MW in 1984 (not including main stem hydro-additions) to the projected 35,160 MW requirement for 1985 shows that adequate capacity is being planned for basin needs to that date. This does not include imports or exports of basin power and does not mean that there will be no problems in getting units in service or in distributing power generated. It does mean, however, that the service potential exists, and that basinwide planning is being conducted to insure that future needs are met.

CHAPTER 4. FEDERAL ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION

INTRODUCTION AND LEGISLATIVE BACKGROUND

Prior to 1975, energy research and development was conducted by several federal agencies, with a major portion of the funding being devoted to nuclear energy R&D. With the Middle-East oil embargo, national emphasis was focused on the country's need for becoming energy self-sufficient and was a factor in Congress passing legislation to bring together in a single focus our major energy R&D efforts.

The Energy Reorganization Act of 1974 (P.L. 93-438) was signed into law on September 11, 1974, and the Energy Research and Development Administration (ERDA) was officially established as of January 19, 1975. This act transferred to ERDA certain functions of the Atomic Energy Commission, National Science Foundation, Environmental Protection Agency, and the Department of the Interior. For the first time, it brought together into one agency major federal programs of research and development on all forms of energy, and it also organized those programs for cooperation with industry, academic institutions, and other organizations in the Nation's rapidly expanding energy research and development effort. In addition to creating ERDA, the legislation also formed a Nuclear Regulatory Commission (NRC) which has assumed the licensing and regulatory responsibilities for commercial nuclear power plants and radioactive materials previously carried out under the Director of Regulation within the Atomic Energy Commission.

ERDA's mission in energy research and development includes:

- Continuing the research of the AEC in nuclear fusion and fission, working with industry to design, develop, and demonstrate increasingly more effective nuclear power systems to meet our growing electric power demands;

- Continuing to expand fossil fuels research programs which had been initiated within the Department of the Interior, in order to utilize the Nation's immense national reserves of coal and oil shale, with emphasis on advancing the technology for the clean use of coal including gasification and liquefaction;

- Strengthening our scientific and engineering research and development on making use of new and potentially important forms of energy such as solar and geothermal sources;

- Moving into a substantial new effort in energy conservation research and development;

- Continuing to expand the programs of environment control technology and assessment of environmental and health effects of energy technologies; and

- Continuing to support strong basic research programs, in such areas as physics, environmental, and biological sciences and extend these scientific capabilities to support all energy areas--not just nuclear energy.

During ERDA's first year, significant strides were made toward developing a national energy research and development plan and on mobilizing the talent and organizational steps necessary to aggressively move ahead in the development of U.S. energy resources. In June 1975, ERDA published "A National Plan for Energy Research, Development, and Demonstration; Creating Energy Choices for the Future." This plan was developed in consultation with other government agencies and with representatives of the private sector in order to make it an integral part of a broader national response to energy challenges. The plan is designed to achieve solutions to energy supply system and associated environmental problems in (a) the immediate and short-term (to the early 1980's); (b) the middle-term (the early 1980's-2000); and (c) the long-term (beyond 2000).

HIGHLIGHTS OF FEDERAL ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION

This section presents highlights of energy research, development, and demonstration activities being conducted or sponsored by ERDA, EPA, and the Department of the Interior, Bureau of Reclamation (USBR). The section is divided by types of energy used for production of electricity and indicates which agency is the research sponsor.

Fossil Fuels

Work is underway or contracts have been let to test, demonstrate, or develop more efficient techniques for the recovery and use of coal, oil, and shale. These programs, including the processing of clean fuels from coal, shale, and biomass, are important for the near future. A major synthetic fuels commercialization program was proposed and a synthetic fuels pilot plant was dedicated in 1975.

Energy Research and Development Administration.

- Coalcon Company, New York City, was awarded a contract to design, construct, and operate a demonstration plant using a hydrocarbonization process to convert high sulfur coal to a clean burning liquid and pipeline quality gas. The Foster-Wheller Energy Corporation, Livingston, New Jersey, is to develop and design a pilot plant which will produce low-Btu gas from coal. Northern States Power will provide a site for the combined-cycle coal gasification pilot plant at its Lawrence Plant, Sioux Falls, South Dakota.

• Through its contractor, Conoco Coal Development Company, Library, Pennsylvania, ERDA continued the successful operation of its carbon dioxide acceptor process pilot plant in Rapid City, South Dakota. ERDA's objective in keeping the 40-ton-per-day plant operating is to identify commercialization process and equipment problems. The operation of the plant has recorded prolonged runs with process efficiencies of 77 percent.

• Montana Energy and MHD Research Development Institute, Inc. was selected to develop engineering information on magnetohydrodynamic (MHD) generators and systems. Emphasis is being placed on open cycle MHD, utilizing coal as the primary fuel.

• An agreement was signed with El Paso Natural Gas Company to demonstrate increased natural gas production by utilizing massive hydraulic fracturing in the Green River Basin of Sublette County, Wyoming.

• Five firms responded to an ERDA request for technical proposals to design, construct, and operate a demonstration plant for converting coal to pipeline quality gas. ERDA also solicited proposals to design, construct, and operate demonstration projects for converting coal into clean fuel gas (low Btu) for power generation and large and small industrial users.

• In February 1976, ERDA solicited technical proposals for projects to develop in place (in situ) shale oil recovery technology. Oil shales of Colorado, Utah, and Wyoming have been identified as occurring in four different types of deposits within the overall context of the Green River formation. Several in situ processes could apply to one or more of these deposit types, but no single process is considered applicable to the full range of deposits.

Environmental Protection Agency.

• Several demonstration projects are being funded across the country to prove the technology and reliability of flue gas desulfurization (FGD). The Industrial Environmental Research Lab-RTP is responsible for this program.

• Primarily, laboratory and pilot plant work on fluridized bed combustion is aimed at proving the technology that is thought to improve thermal efficiency while at the same time reducing emissions.

• New source performance standards for nitrogen oxide emissions are about to be proposed for lignite fired power plants. The limit will be equal to or more stringent than the present regulations.

• Coal extraction studies covering impacts of coal mining on surface water quality and ground water quality are being performed in the Northern Great Plains. Methods to minimize pollution from mining activities are being demonstrated.

• Guidelines for chemical and thermal effluent limitations applicable to coal fired power plants have been promulgated. Studies involving the identification of trace metals originating from conversion facilities are being performed by EPA Region VIII and IERL-RTP.

Water conservation studies, leading to potential field demonstration sites, involve chemical limitations to water recycled in cooling towers and water treatment for additional plant use or discharge are being performed by Corvallis Research Lab. The lab is also investigating possible uses of dry on wet-dry cooling and the economics of such utilization.

Nuclear Energy

In 1975, important strides were made on the work associated with the breeder reactor program, and on the future supply of enriched uranium to fuel nuclear plants. Major steps were taken to identify and resolve problems in the nuclear fuel cycle, including the reprocessing of spent reactor fuel and safe disposal of waste products. A final environmental statement was issued on the Liquid Metal Fast Breeder Reactor program, and ERDA concluded that a continued strong research and development effort is necessary to make future decisions about the use of the breeder as a commercial electric power producer.

Energy Research and Development Administration.

• Liquid Metal Fast Breeder Reactor (LMFBR) Program

The final environmental statement for the LMFBR program was issued December 31, 1975, and included consideration of public comments in the Preliminary Environmental Statement, the testimony presented at the public hearing, the ERDA Internal Review Board report, and the administrator's findings. The administrator's statement indicates that on the basis of today's knowledge, sufficient data could be available as early as 1986 for ERDA to make a decision on the commercial acceptability of the LMFBR.

The construction of the Fast Flux Test Facility (FFTF) project was 55 percent complete through December 1975. This represents a 19 percent increase in construction completion over the last year. The revised total estimated cost of this project is $540 million, of which $420 million in funds has been fully authorized and appropriated through FY 1976.

Progress was also made on the Clinch River Breeder Reactor (CRBR) project during FY 1975. The major accomplishments on this project include the completion of key equipment specifications; approval of preliminary general arrangement drawings for all major buildings; the development and operation of test programs in the areas of plant reliability, reactor, and plant thermal-hydraulics, leak detections, etc.; the docketing of the Environmental Report and

Preliminary Safety Analysis by NRC; the placement of purchase orders for the design and fabrication of the plant and prototype control rod drive mechanisms, main coolant pumps, and the plant turbine generator; and the submittal of contracts for design and fabrication of the reactor vessel and for design of the intermediate heat exchanger.

The total funding required to support the above accomplishments for FY 1975 was $73 million, $63 million of which was provided by ERDA and $10 million provided by utility and other participants' contributions.

- Nuclear Fuel Assurance Act

Several significant actions have been taken to further enhance the viability of the nuclear power option. The proposed Nuclear Fuel Assurance Act, aimed at creating a private, competitive uranium enrichment industry, has been submitted to Congress. When enacted, the law will authorize ERDA to negotiate and participate in cooperative arrangements with private industrial companies. These arrangements will be designed both to protect the public interest and permit the United States to again become a reliable international supplier of uranium enrichment services.

- Light Water Reactor Fuel Cycle

Spent fuel reprocessing and recycling services have in the past been available on only a limited basis. Faced with the forecast of a considerable growth in demands for such services, a continued lack of reprocessing capacity may result in increased needs and demands on the already limited uranium milling and enriching capacity and could potentially reduce the future contribution of nuclear power to the U.S. energy independence objective. On February 26, 1976, ERDA published a request in the Commerce Business Daily for expressions of industrial interest in submitting proposals for the construction and operation of reprocessing and recycling facilities. Twenty-six firms have stated their intention to respond to the ERDA request.

- Commercial Waste Management

ERDA has recognized the growing concern over the ultimate disposal of high-level radioactive waste from commercial nuclear power as a key factor in public acceptance of nuclear energy and in response, has proposed a major increase in the level of research and funding in the FY 77 budget. The new expenditure level would provide for an evaluation and screening of prospective geological disposal sites. As a result, a mid-1980's target of beginning test emplacement of high level waste in several regional repositories has been established. In the event that federal custody of commercial high-level or trans-uranic waste should be required by NRC regulations prior to availability of geological repositories, preliminary design and safety evaluations have been completed on several approaches to retrievable storage that could be used to rapidly construct the necessary facilities at an existing ERDA nuclear site.

• Nuclear Research and Applications

A successful launch of the NASA Viking I and II spacecraft powered by Radioisotope Thermal Electric Generators (RTG's) was achieved in 1976. Also in the past year, the fabrication of the Plutonium fueled Multi-Hundred Watt (MHW) isotope generator was completed for use on the DOD Lincoln Experimental Satellites.

Three important milestones in fusion were reached in 1975. (1) At Lawrence Livermore Laboratory in California, reactor-level temperatures of 130 million degrees centigrade were achieved while fusion plasma confinement time was increased ten-fold. (2) Another type of fusion experiment at the Massachusetts Institute of Technology improved the combination of confinement time and plasma density. (3) Laser fusion experiments demonstrated laser-initiated thermonuclear reactions, an encouraging advance. Steady progress has also been made on important engineering problems including superconducting energy storage coils and large superconducting magnets.

Solar Energy

Energy Research and Development Administration. Demonstration programs in two types of solar energy that may have an important long-term impact on the Missouri River Basin states were begun under ERDA direction in 1975. The two types are the production of electricity from the heat of the sun and the heating and cooling of buildings.

• Heating and Cooling of Buildings

The goal of the federal demonstration program is to bring the price of solar heating down through improved technology and through mass production.

Solar heating can already be competitive with the cost of electric heating in colder climates. However, it is not yet competitive with gas or oil heating at current prices. The location of federal demonstration projects in the United States is shown in Figure 2. Colorado is one of the leading states in residential projects. This concentration reflects three important factors in the practicality of solar heating; a relatively cold climate (thus heavy energy demand for heating), high percentage of sunny days, and locally available solar heating systems.

In evaluating more than 100 solar heating systems, ERDA found 36 of the systems technically acceptable for use in its demonstration program. Three of these systems are manufactured in Colorado, and two are produced in Minnesota.

The Department of Housing and Urban Development selected five Colorado locations and one location each in Montana, Minnesota, and Missouri to receive grants for solar heating units in residential buildings. The Department of Defense selected military bases in

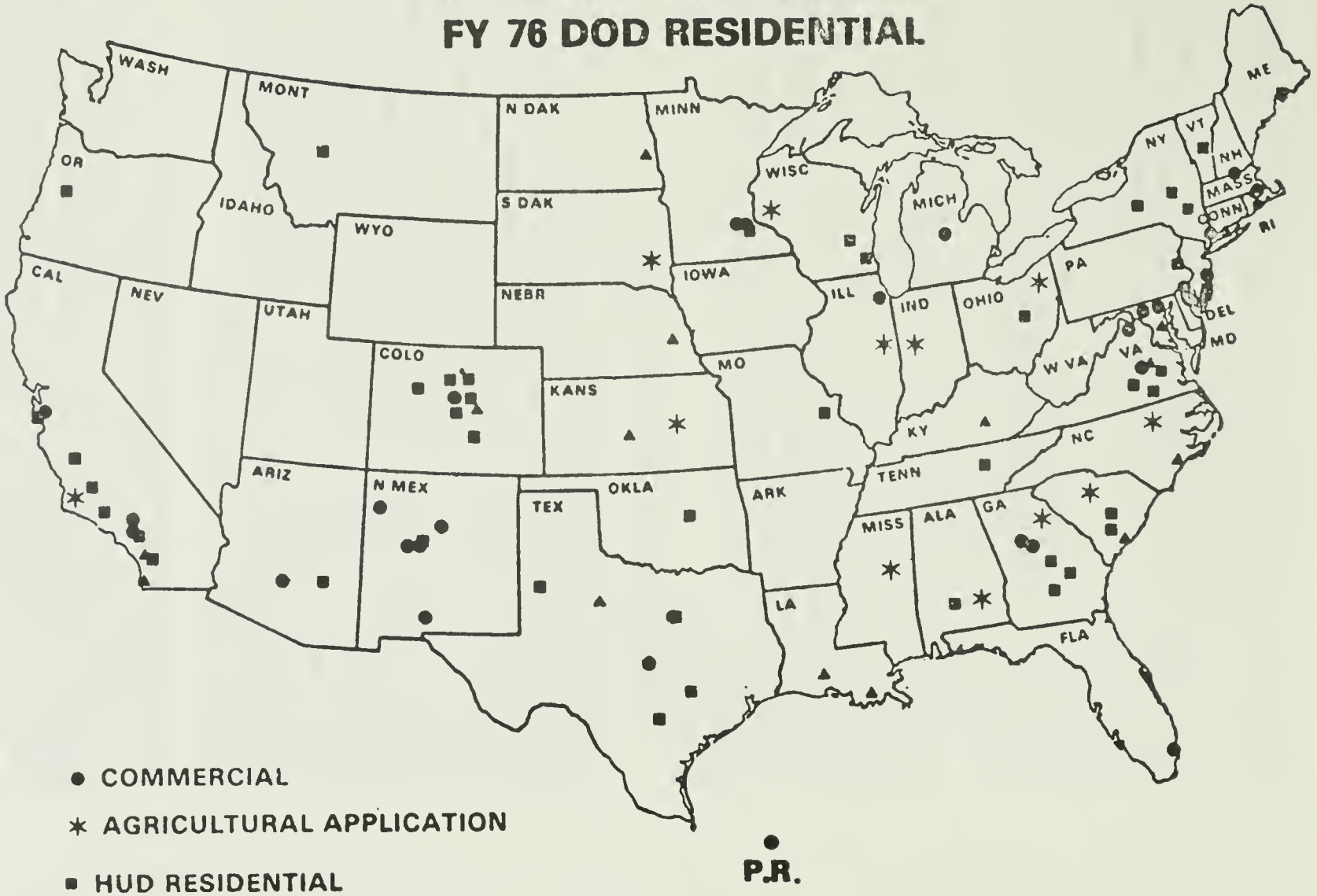

SOLAR HEATING PROJECTS PRIOR TO FY76
FY 76 PROJECT STARTS
FY 76 HUD RESIDENTIAL
FY 76 DOD RESIDENTIAL
WASH
MONT
N DAK
MINN
OR
IDAHO
WYO
S DAK
WISC
MICH
NY
VT
ME
NH
MASS
CONN
RI
CAL
NEV
UTAH
COLO
NEBR
IOWA
ILL
IND
OHIO
PA
DEL
MD
W VA
VA
KANS
MO
KY
NC
TENN
ARIZ
N MEX
OKLA
TEX
ARK
MISS
ALA
GA
LA
FLA
P.R.
COMMERCIAL
AGRICULTURAL APPLICATION
HUD RESIDENTIAL
DOD RESIDENTIAL

FIGURE 2

North Dakota, Nebraska, Kansas, and Colorado for testing solar heating in base housing projects.

A solar unit has been suppling more than half the heating needs for a swimming pool area at North View Junior High School in Minneapolis, Minnesota, since April 1974. This was the first commercial-size solar heating unit in the nation to complete its testing program and be turned over to the owners of the building for continued operation. In Boulder, Colorado, plans have been made for a solar heating system for the existing post office building. An underground bookstore using solar heating and cooling was to have been constructed at the University of Minnesota in 1976.

Solar energy will provide part of the heating and cooling for a new electric power substation to be constructed by the Bureau of Reclamation near Greeley, Colorado. The solar unit for the Ault Substation will be the first ever installed in a Bureau facility. The solar unit--estimated to cost about $49,000--will provide about 80 percent of the required heating and 10 percent of the cooling for the substation. Although the substation will be unmanned most of the time, a temperature range between 40 to 80 degrees must be maintained in the building to protect sensitive equipment. Conventional heating and cooling systems will be installed as a backup to the solar unit.

- Electricity from Solar Heated Boilers

Although technology already exists to produce power-station quantities of electricity by concentrating the sun's rays on a boiler to produce steam to drive turbines, it is not certain that this can be done economically. To explore and remove the uncertainties of such a system, ERDA in 1976, began a program to build a test facility and pilot plant at the Sandia Laboratory in Albuquerque, New Mexico, capable of supplying electricity for a city of 10,000 people. The plan called for construction scheduled for 1978 and operation in 1980. The estimated cost of this 10-megawatt pilot plant is about $85 million. Both the test facility and the later power plant will feature large fields of sun-tracking mirrors that reflect and focus the sun's heat onto boilers at the top of a tower. Seventy-eight tracking-mirror modules will be constructed and are expected to provide the facility with a 1-megawatt capability by late 1977. About 240 additional modules will be necessary to reach a planned 5-megawatt capability in 1978.

- Other Solar Energy Research and Development

Solar cells that can produce electricity directly from sunlight are the main source of electricity for spacecraft. During 1975, ERDA awarded about $12 million in research and development contracts aimed at producing these cells at a cost that would make them available for more widespread use. To be competitive with electricity from conventional sources, the cells will have to be available at not more than one-fiftieth of their current cost. The ERDA goal is to achieve that cost reduction by 1985. Further cost reduction, combined with development of economical electric storage methods, could mean that homes, offices, and factories could have their own individual sources of electricity.

Another research program is aimed at producing electricity from ocean based power plants that will use the difference in temperature between deep and surface water to boil ammonia and drive a turbine. Other, non-electric research is exploring the practicality of producing methane gas, methanol (liquid), and solid fuels from waste products and from plants grown on energy farms.

Geothermal Energy

Energy Research and Development Administration.

- The first experimental step in recovering useful heat from a hot dry rock geothermal resource was recently completed in New Mexico. In this effort, water circulation for heat extraction was established by drilling and interconnecting, by hydraulic fracturing, two deep wells.

- A major advance in the utilization of high temperature, high salinity reservoirs has been made through the construction of a 10 MW equivalent test loop. The cooperative program between San Diego Gas and Electric Company and ERDA is located in Imperial Valley, California, and was completed in early 1976.

- ERDA has now identified a large reservoir of geothermal fluid in Idaho to be used in support of the development of economical utilization of moderate temperature--low salinity resources.

- Using a new technique and data from thousands of existing oil wells, Texas scientists have recently identified a major and very promising geopressured geothermal deposit near Corpus Christi. This site may later support a pilot plant test of available energy conversion technology.

- An engineering study has been completed and drilling is underway in support of a joint U.S.-state government project in Boise, Idaho, for direct heating of buildings using geothermal energy. When completed, it will more than double the present U.S. use of geothermal energy for non-electric purposes.

- ERDA funded a USGS assessment of the geothermal resources of the United States (USGS Circular 726) which indicated present resources in excess of 240 gigawatt centuries of potential electrical power.

- ERDA published draft regulations for a loan guaranty program that is expected to provide at its start $50 million annually in guarantees for industrial development of geothermal resources.

- ERDA and the Department of the Interior's Bureau of Reclamation have jointly undertaken a project to establish a geothermal component test facility at East Mesa, California.

Wind

Energy Research and Development Administration

• In October 1975, ERDA and the National Aeronautics and Space Administration put a large wind-driven test turbine into operation at Sandusky, Ohio. In winds of 18 mph, this turbine has proved capable of generating 100 kilowatts of electricity, about the amount needed for 25 homes. During 1976, ERDA will select four sites for experimental wind electric generating systems, the largest of which should produce approximately 1,500 kilowatts of electricity. The energy that is produced from each system will be added to existing electric utility networks. These four pilot projects are of particular importance for the high wind states within the basin.

Broad Energy Studies

Bureau of Reclamation.

• The Bureau of Reclamation has launched a major new study this year to identify and appraise ways to expand water-related energy production in the western United States. Within a broad framework, the bureau's "Western Energy Expansion Study" will investigate potential new sources of hydroelectric power and consider possible integration of wind and solar energy with hydropower. The study will also inventory and compare opportunities to increase the availability of energy through water management and development. As the potentials are identified, an analysis will be made to determine which options merit more detailed investigation and possible development.

The study will include such elements as:

--Possible use of federal reclamation project reservoirs and canals to provide water for cooling thermal powerplants.

--Revision of water and power operations at existing hydroelectric facilities to minimize power requirements for pumping or to maximize the generation of power, including the purchase of non-federal baseload power to meet federal pumping requirements, thus freeing hydroelectric facilities for peaking purposes.

--Identification of additional energy conservation measures by users of federal power.

--Consideration of structural modifications and additions at existing federal hydroelectric power facilities.

--Identification of potential new conventional and pumped storage hydro sites and assignment of priorities to possible future studies including feasibility investigations of known hydropower generating potentials.

--Appraisal of possible secondary uses of thermal cooling product water such as warm water irrigation.

--Use of waste water for thermal cooling.

--Potential improvements in power transmission through consolidation of lines, exploration of joint ventures with private industry, and impacts of new technology on transmission line inter-ties.

--Consideration of possible integration of other forms of energy with the production of hydroelectric power. These include development of coal and oil shale resources, geothermal power sources, and solar and wind energy.

Energy Conservation

Energy Research and Development Administration.

Important highlights of ERDA's 1975 Conservation R&D programs include:

(1) Ground-breaking in Knoxville, Tennessee, for a test dwelling using the Annual Cycle Energy System. The system could save about 50 percent of the annual energy now used for heating, cooling, and hot water.

(2) Design of a demonstration plant in Florida for converting urban liquid and solid waste to methane.

(3) Plans to evaluate the advantages of inexpensive fuel economy devices designed to reduce drag on large vehicles and trucks.

(4) Support for development of comprehensive energy management and conservation plans for the cities of Clarksburg, West Virginia, and Hobbs, New Mexico. The plans, when fully implemented, will enable those communities to conserve maximum amounts of energy; make the best use of their energy resources; and minimize the adverse economic impacts of energy shortage.

- Pasadena, California, Total Energy System

A $500,000 contract has been awarded to the city of Pasadena to plan and design a "total integrated energy system" offering an energy-efficient way to provide utility services to a downtown redevelopment area. A key feature of the project is an engineering analysis to determine the feasibility of placing a central "energy plant" within a downtown commercial redevelopment area, and to provide a multitude of utility services to that area. The plant will be capable of supplying energy to the community in several forms, including heat and electricity. By locating the plant within the community, it will be possible to use the waste heat from power production -- energy that is usually discharged to the environment -- to supply other utilities such as domestic hot water, space heating, and cooling.

A variety of energy sources will be considered to power the "energy plant," including conventional fuels such as coal, oil, and natural gas, and also solar energy and energy from burning the solid wastes generated by the community. The facility will be tied in with the electrical grid of the local utility that serves the Greater Pasadena area. During times when it produces more electricity than is needed in the immediate redevelopment area, the surplus can be transferred to the utility. By the same token, the local utility can provide additional electricity to the system serving the redevelopment area whenever the supply produced by the "energy plant" is not sufficient to meet demands. The results of the feasibility analysis and the conceptual design for the central "energy plant" will be published by ERDA and should serve as a model that may be utilized by other municipalities through the country.

- Battery Energy Storage Test Facility

A Battery Energy Storage Test (BEST) facility, to cost approximately $6.5 million, will be built and operated about 30 miles southwest of Newark, New Jersey, as a joint project of the U.S. Energy Research and Development Administration (ERDA) and the Electric Power Research Institute (EPRI).

The Public Service Electric and Gas Company (PSE&G) of New Jersey has been selected for the design, construction, testing, and operation of the BEST facility. A major step in both ERDA's and EPRI's energy conservation program, the BEST facility will provide the capability for testing battery energy storage systems for utility load-leveling, and thereby play an important role in improving the efficiency of the nation's electrical generating system.

Planned for startup in 1979, the BEST facility will begin experimental operation using lead/acid storage batteries. More advanced batteries will be incorporated in the BEST program as they become available. The BEST facility will be located at PSE&G's Sunnymead Road Substation, where it can be easily interconnected with the utility's grid. This will permit the facility, operating as a load-leveling battery power plant, to function under realistic conditions. A key advantage of the BEST facility is that it can store electrical energy generated by less expensive coal and nuclear power plants during periods of low demand for use during times of peak demand. Furthermore, storage battery facilities can be located close to electric load centers, thus reducing or deferring additional expenditures in transmission and distribution facilities.

- Light Bulb Breakthrough

A light bulb that can last a decade and use 70 percent less energy than conventional bulbs will be developed over the next year under an ERDA contract with the Lighting Technology Corporation of Fullerton, California. The fluorescent "Litek" bulb resembles a 100-watt incandescent bulb, fits standard sockets, and produces a warm white light similar to the standard household bulb. Because it contains no wire filaments that can burn out, it can last at least several years and possibly a decade or more.

Preliminary studies show that full nationwide use of this new fluorescent lamp could save more than the equivalent of 500,000 barrels of oil per day. Incandescent lighting presently costs Americans more than $6 billion annually.

National Oceanic and Atmospheric Administration (NOAA).

In November 1975, the Commerce Department's National Oceanic and Atmospheric Administration initiated a weekly weather-information service directly reaching 48 state capitals. The program was designed to help states determine where they stand in heating-fuel usage and to project weather effects upon heating-fuel needs. With the information, state energy advisers should be able to help anticipate natural-gas requirements on a week-to-week basis and to initiate conservation measures where necessary during cold periods. The Commerce Department's goal is to provide forecasts sufficiently in advance to make fuel distribution adjustments possible with a minimum of hardship.

In order to use the new service, state officials will have to become familiar with a concept called the "heating degree day." This concept, requiring no actual measurements of fuel use, was developed many years ago by heating engineers to provide a useful measure of the way cold weather of a given severity and duration affects the consumption of heating fuel.

CHAPTER 5. ENVIRONMENTAL CONCERNS RELATED TO POWER PRODUCTION AND ENERGY DEVELOPMENT

The national commitment to achieve independence or near independence in the area of energy resources has resulted in intensive program efforts to identify, quantify, and develop the energy resource potentials of the nation. In regard to new energy development initiatives, the middle and upper segments of the Missouri River Basin are receiving considerable attention due to the presence of extensive deposits of low sulfur coal.

In addition to coal, the Missouri River Basin contains economically recoverable quantities of natural gas, petroleum, and uranium. Development of solar and wind resource potentials in the basin could have significance as a non-polluting energy source in the future. Although the potentials for additional hydroelectric power development are somewhat limited, the water resources of the Missouri River Basin will play a crucial role in development of the basin's other energy resources, particularly coal.

A number of concerns have been raised regarding the possible impacts related to the accelerated effort to develop the nation's energy resources. In March of 1974, a federal interagency task force was established to provide guidance to the Office of Management and Budget and appropriate agencies in the identification, prioritization, and funding of comprehensive research programs designed to evaluate the effects of energy use on human health and environmental values.

For 1975, approximately $100 million was appropriated to support the energy-related supplemental research program. More specific information on the distribution of funds by program element and agency can be obtained from the "Report of the Interagency Working Group on Health and Environmental Effects of Energy Use" (the King Report).

In the Missouri River Basin, intensive efforts to develop the energy resource potentials of the basin, particularly those in the northern Great Plains, have generated considerable controversy regarding the possible environmental and social consequences of such developments. The nature of the social and environmental concerns are diverse. They include the possible adverse effects of development on the social structure of local communities, crime rates, adequacy and costs associated with waste water treatment facilities, school systems, air quality deterioration, water depletion, decrease in agricultural production capabilities, effectiveness of reclamation measures, post-development economies, and ecological values. In response to these concerns, numerous studies have been initiated by industry, universities, the scientific community, and government in an attempt to more clearly define the impacts that can be anticipated from an accelerated level of energy development activity in the northern Great Plains.

Selected information useful in understanding the above concerns has been obtained from Volume 1 of the Energy Research Information System report developed jointly by the Old West Regional Commission and the U.S. Forest Service, and has been compiled as an unpublished appendix to this document. A copy of the appendix titled "Summaries of Environmental Studies Related to Power Production and Energy Development," may be obtained by request to the Missouri River Basin Commission office. A brief summary of the selected research projects is also provided in the appendix. The number of projects summarized by subject area is as follows:

Subject Area	Number of Projects Summarized
Coal	
Reclamation	21
Water Resources	17
Atmospheric	17
Coal Conversion	24
Mining and Extraction	13
Socio-Economics	23
Petroleum and Natural Gas	7
Nuclear	2
Alternative Energies	8
Land Use	8

More specific information on the studies is available from the Old West Regional Commission or other information systems such as the Federal Energy Information Locator System developed by the Federal Energy Administration.

The following discussions provide some insight into the major environmental problems being experienced or expected in relation to energy development and further serve to exemplify the need for research in the subject areas.

COAL

Reclamation

Perhaps second only to regional concerns over social, cultural, and economic changes brought about by large scale industrialization, principally related to the extraction and use of the basin's buried energy fuels, is the concern over our ability to reclaim lands mined for shallow deposits of coal. The reclamation of mined lands cannot be overemphasized because it is critical in assuring that surface mining takes place as only a temporary use of the land.

In view of the wealth of experience gained in revegetating agricultural lands and lands disturbed during highway construction and urban building, it is useful to question the differences, if any, between agricultural or highway reclamation and reclamation of mined lands. Generally, a significant difference appears in the thickness of earth materials disturbed or "crushed" into relatively small silt, sand, gravel, and boulders during surface mining. A second substantial difference exists, in many cases, because the materials lying on top of the coal are, by their geologic nature, inherently saline. This salinity is basically derived by virtue of their high sodium mineral content.

Inhabitants of the Upper Missouri River Basin are only too familiar with the potential problems of erosion (water and wind) of lands from which vegetation is removed. They are also aware of the difficulties in attempting to reestablish premining vegetative systems on the mined lands. Other challenges encountered when reclaiming mined areas involve the slope and aspect of graded lands and water quality and quantity.

Research activities during 1975 have included numerous field studies as well as greenhouse studies, the latter designed to test preliminary hypotheses about germination and early growth. At many surface coal mines, there are large scale current reclamation efforts that are considered "operational," that is, an integral part of the mining operation. Unfortunately for those reclamation efforts where the intended post-mining land use is one requiring low or no maintenance (fertilizer, irrigation, etc.), many years will be required to determine whether revegetation efforts have been truly successful in terms of achieving plant stability, succession, forage, and so on. In select locations, there is certainly more promise of success. Fortunately for the majority interests desiring a return of lands disturbed during coal mining to a post-mining agricultural use (crops or grazing) as well as those concerned with the maintenance of wildlife populations, the thick deposits of shallow western coals provide a substantial income per unit of land area disturbed. Quite often this fact alone can provide an economic incentive adequate to encourage the return of the lands to a productive use.

While there has been proper concern over the relative importance of land disturbance caused by surface mining of coal or other minerals in the past, those lands with deposits of economically minable coal, at least five feet thick and lying less than 200 feet below the surface, occupy a small percent of the total Missouri River Basin area. Since the overburden above coal seams is often thinnest in the valleys and in the lower plains, it is most economical to mine these coals. These same valleys and plains are often the mainstays of the agricultural operations -- operations which in turn form the basin's economic foundation and which will likely persist in the long term as the area's economic backbone. Thus, the lands that may be disturbed by surface mining of coal tend to include a high percentage of those lands currently used for more intensive agriculture -- as opposed to less desirable lands in the areas of higher elevation, rocky outcrops, and somewhat higher precipitation.

Water Resources

Water resources will play a crucial role in directing the types, magnitude, and location of coal-based energy conversion facilities in the Northern Great Plains. The more concentrated deposits of economically recoverable coal are located in areas where water surpluses do not normally occur. An optimum development level of minemouth facilities would necessitate increasing the availability of water through construction of surface water diversion and storage facilities and utilization of area ground water supplies.

The two-unit Leland Olds lignite fueled electric plant near Stanton, North Dakota, represents a mine mouth generation facility located adjacent to the surface mine. The 672 MW plant is operated by the Basin Electric Power Cooperative.

There are a number of widespread concerns regarding the use of Missouri River Basin waters to support energy development initiatives. Some of the more probable impacts on the water resource base include the basic concerns associated with water depletions, alteration of streamflow patterns, transbasin diversions related to coal slurry pipelines, water quality deterioration, destruction or alteration of established aquatic ecosystems, limitations on water use options, and alteration of aquifer integrity including surface-ground water interchange. Although much of the development will occur in upper segments of the Missouri River Basin, the effects of water depletions and water quality deterioration will be evident in downstream reaches of the Missouri River main stem as well.

Environmental studies which have been initiated to better understand the problems related to development of the coal resource are numerous and diverse. Simplistically designed environmental studies considered acceptable in the past can no longer be considered adequate due to the magnitude, types, and sophistication of projected coal-based energy conversion facilities and associated development activities.

Atmospheric

There are various atmospheric pollution problems associated with development of the coal reserves in the Missouri River Basin. Of the atmospheric pollutants for which EPA has promulgated standards, suspended particulates, sulfur oxides, and nitrogen oxides are emitted in sufficient quantities to be of serious concern. Suspended particulates are emitted in significant quantities by every type of energy-related facility currently under development.

There are two primary sources of particulate matter emissions. Stack emissions from steam generators both from electric power plants and process steam generators are emitted in sufficient quantities to significantly degrade air quality. However, these are relatively easy to control with available control technology, and a single facility would not be expected to produce a health hazard. Even with available control techniques, a number of facilities would collectively have a significant impact on the visibility range and have the potential to contribute to weather modification. A second source of particulate emissions - commonly referred to as fugitive emissions - is of even greater significance than stack emissions. The importance of these emissions results because of the difficulty in controlling their release. In energy development, the mining and handling of coal represents the most common source of these emissions. Dust is entrained into the air from spoils piles, coal piles, dirt roads, and various other sources. The only known control techniques are wetting and revegetation.

Sulfur oxides and nitrogen dioxide are produced primarily from the combustion of coal. Significant quantities of sulfur oxides are also produced in coal conversion processes via flaring of H_2S. Both of these pollutants are associated with several impacts - health and vegetation, visibility impairment, and acid rain.

Trace metals represent another group of atmospheric pollutants generated by coal related facilities. These metals are released by virtue of their presence in the raw coal. While the emissions are not presently regulated, their significance is under study by a number of research bodies.

Coal Conversion

As with any energy or fuel conversion activity, coal conversion can result in environmental impacts to the water, air, and land. The quantity of water effluents, air emissions, solid wastes, and associated land impacts are dependent upon considerations such as the type of process, type of intermediate and end products, pollution control measures utilized, and variable site-specific factors. Present quantification of wastes from such facilities can only be based upon extrapolations from laboratory experiments, bench scale tests, and limited pilot plant operations since no commercial size conversion facilities exist today in the United States. Some waste and residue information has, however, been gained from commercial size operations outside the United States.

The surface water quality impact of coal gasification in the Missouri River Basin should be low since no discharge of process or cooling waste water effluents is anticipated. Even so, diminished surface water quality could possibly occur through the depletion of the water source by water withdrawal. Current studies on water reuse/conservation in coal conversion facilities, however, indicate that significant reductions in water consumption may be achieved through careful planning and design considerations.

Unless adequate planning and maintenance of total retention facilities and proposed deep well injection systems are conducted, ground water may be significantly impacted by coal conversion. Design, construction, and maintenance of total retention facilities must insure that contaminated waste water is totally contained, and that proposed deep well injection systems will not introduce waste water into presently utilized or future source aquifers.

Air emissions will not directly arise from coal conversion because pollution control processes will be utilized. Direct air impacts will be minimized, but some indirect emissions will result from the pollution control measures themselves. These emissions can be anticipated from control and by-product systems such as sulfur recovery and boiler units. The quantity of air emissions will vary depending upon such factors as the type of controls utilized, the quality of the raw coal, type of by-products to be generated, and by-product control equipment.

The primary source of solid wastes resulting from coal conversion will be the ash from the combustion of the coal itself. Additional wastes can originate from by-products if they cannot be sold, spent catalysts if not regenerated, and sewage and water treatment solids if not controlled. Environmentally sound solid waste disposal techniques will be required to minimize potential impacts.

Land impacts will depend upon the absolute amount of land required and disturbed by the facility. Impacts can be mitigated by proper design, planning, and maintenance of the facility site.

Because announced plans indicate that high Btu gasification will lead the conversion facilities in the Missouri River Basin, the above environmental impacts are more representative of this type of technology and facility. Similar impacts would be anticipated from low Btu gasification and liquefaction as well. In situ gasification could have impacts similar to surface retorting, but additional ground water and land subsidence impacts may occur because of the nature of the process.

Additional environmental impacts will occur from conjunctive development associated with any conversion facility and must be considered if the total impact is to be determined.

Additional studies are needed in areas of water effluent and air emission characterization and quantification for a commercial sized facility. The energy efficiency of the conversion process and auxillary requirements should also be examined.

There is an immediate need for technical programs through which environmental impacts of the various processes can be assessed. Programs should identify problem areas requiring further study, work toward development of control technology, quantify the environmental impacts, and establish criteria for site selection and control technology for the various processes. The ultimate goal of these programs would be to ensure that the environmental impacts of coal conversion developments are minimized.

Mining and Extraction

The surface mining and extraction of energy resources, principally bituminous coal and lignite, in the Missouri River Basin has the potential of producing environmental impacts which will affect the quality of the air, lands, and waters of the basin. Some of the major potential impacts include the deterioration of surface water quality due to increased sediment loads and coal mine leachates, the disturbance and contamination of shallow ground water systems, the degradation of air quality as a result of fugitive dust and emissions from attendant coal preparation facilities, and the direct disturbance of lands and existing land uses by the extraction process.

The magnitude and duration of such environmental impacts is primarily a function of the mining and reclamation practices undertaken by the operator and the extent of environmental conditions. Practices which might be implemented by the operator as mitigating measures include: pre-mining planning; the selection of surface mining methods and coal extraction and preparation practices which maximize land conservation and minimize soil erosion; the determination and limitation of air and water quality and impacts; and the utilization of mined land reclamation methods to include selective spoil placement, topsoiling, grading, and revegetation.

Current studies relating to the environmental effects of surface mining and extraction of energy resources in the Missouri River Basin have been oriented toward the determination of baseline environmental conditions in future development areas, the evaluation of environmental impacts resulting from existing mining operations, and the utilization of models or other analytical techniques to project air and water impacts and reclamation potentials. Such studies are currently being undertaken by the Environmental Protection Agency, U.S. Geological Survey, Bureau of Land Management, Bureau of Reclamation, Bureau of Mines, Agricultural Research Service, U.S. Forest Service, numerous state agencies, the Old West Regional Commission, and others.

Socio-Economics

Socio-economics is a big word with different meanings to different people. Since people require electrical power in its various end use forms, the study of this area, both from its social aspects and economic impacts, has taken on increased meaning.

Realizing the increased demand for coal for conversion to electrical power, many federal and state governmental agencies have initiated social and economic studies to define needs and potential problem areas.

PETROLEUM AND NATURAL GAS

Various studies have been initiated to address the air, land, and water impacts associated with oil and gas exploration, drilling, and production within the basin.

Air quality concerns are primarily related to the emission of H_2S and HC during production operations. Production of oil using primary, secondary, and tertiary recovery techniques will influence both ground water quality and quantity. The disposal of drilling muds and brine wastes can affect land and water quality.

The presence of metals in petroleum becomes more significant as the utilization of residual fractions increases and as a result of the need to process lower quality world crude oils. Fortunately, new processes with high degrees of selectivity hold considerable promise for the removal of metals from crudes and crude derivitives.

NUCLEAR

Due to the limited number of nuclear facilities in the Missouri River Basin, the possibility of a nuclear catastrophe associated with these plants is somewhat remote. Concerns over radioactivity are not only limited to plant operations but include problems associated with mining activities as well.

In Wyoming, a state which contains approximately 35 percent of the total U.S. uranium reserves, extensive development of uranium reserves could greatly increase potentials for radioactive contamination. Other problems of importance include the presence of radon gas, the infiltration of radium into ground waters, reclamation of mined areas, and the disposal of spent reactor fuels. The last concern is of particular significance because such wastes remain in the environment for extremely long periods.

ALTERNATIVE ENERGIES

With the United States becoming more dependent upon foreign energy sources, the possibility of developing nonconventional or exotic energy resources has received considerable support. Due to the limited research in areas of geothermal, solar, and solid waste energy resources, the impacts associated with development of these resources have not been fully analyzed.

Major environmental problems associated with geothermal energy production are: (1) hydrogen sulfide emissions, (2) saline water disposal, (3) land subsidence, (4) land use guidelines and (5) noise. Although there are few known large geothermal resource areas in the Missouri River Basin states, the potential for limited development exists in parts of South Dakota, Montana, and Wyoming.

The sun-rich environs of the Missouri River Basin states hold considerable promise for the development of solar energy potentials. It is expected that ERDA's proposed Solar Research Institute will provide important information on solar-related energy technologies and the identification of possible environmental problems.

Technologies are now being refined to convert solid waste materials into fuel. Large cities such as St. Louis, San Diego, and Chicago have commercial facilities in the early stages of development and testing that are generating electricity from solid wastes. Some of the more immediate environmental problems associated include the high oxygen demand associated with waste materials, sludge disposal, solids, and stack emissions.

LAND USE

With the prospect of extensive surface mining of coal to meet increasing demand for conversion to electricity and the construction of coal-fired plants to provide this electricity, the various western coal-producing states are experiencing a need for comprehensive land use planning efforts. Legislation has been enacted or is in the process of being developed in many of the basin states.

CHAPTER 6. STATE CONCERNS REGARDING ELECTRICAL POWER NEEDS, PROBLEMS, AND ISSUES

This chapter presents the electrical power needs, problems, and issues involving legal, policy, and institutional concerns of the Missouri River Basin states. Each state commission member was asked to provide the information presented here. States were not asked to provide estimates of future generating or energy requirements. Those figures were collected in aggregate and are shown in Chapters 2 and 3 for the entire Missouri River Basin.

One purpose of the information provided in this chapter was to allow summarization of common state problems so they could be recognized and possible solutions coordinated. A summary of common state problems is provided at the end of the chapter. Another purpose was to provide information to planners in power and related fields which will be useful in planning for future activities.

COLORADO

PRESENT ELECTRIC POWER CONCERNS

Problems

- Rapid growth in the demand for electric power (as much as 20 percent annually) in small towns, mountain ski areas, and rural parts of the state is beyond the immediate capacity of smaller power systems to supply. Additionally, more all-electric homes are being built throughout the state because of the existing natural gas shortage, thus, adding more new demand. For the Western Slope power entities, peak electrical demand in the ski areas is concentrated during the winter; whereas, the largest power demand in areas of irrigated agriculture occurs during the summer. Where it is physically and economically feasible, irrigators in the San Luis Valley and other areas have been switching to sprinkler irrigation. In order to obtain the water from deep wells required by the sprinkler systems, two or three times more electric power than used in previous irrigation efforts is needed.

Power officials in the state wonder if such rates of growth in demand can continue and, if so, how they will be supplied in a timely manner--without higher costs resulting for the producer and consumer and regressive impacts accruing to elderly and low income persons and families.

Policy Concerns

- Coordination of the activities of federal agencies appears to be needed so that only one Environmental Impact Statement is required for a project, or for the geographical area in which it lies, or for the resource base it uses. Recently, there have been several Environmental Impact Statements produced at different times, for

different purposes, and covering different geographical areas. An example is provided by the environmental statements prepared on the various aspects of coal development projects. Such future requirements could hold up the supply of coal used for electric power plants.

• Another state consideration involves the concern that the costs of environmental regulations be evaluated against the environmental benefits to be derived. For example, closed cycle cooling tends to lower efficiency in electric power production and increase costs, which must ultimately be passed on to the consumer in the form of higher rates. The cooling tower also increases fuel and water consumption.

• More coordination and forethought is needed to anticipate and mitigate possible social and economic hardships caused by federal energy policy. For example, irrigators using natural gas in the interruptible service class were cut off at times during the 1973 energy crisis. In response, the irrigators switched to electric pumps. This change doubled the demand for electricity in some eastern Colorado counties and caused strained system capacities.

• There is, at present, no coordination of state and federal permitting and environmental review processes. Consequently, many agencies and boards must be satisfied before power facility construction can proceed.

FUTURE ELECTRIC POWER CONCERNS

Problems

• Lead Time

The financing and construction of future capacity is now dependent upon many more factors than previous efforts were. Lead time has, as a result, increased in order to comply with the many state and federal review and permitting requirements.

• Economic Conditions

The effect of inflation, the recession, and tight money, along with delays in securing approvals, will affect the electric energy situation many years in the future. It is not known, however, whether the same economic conditions will prevail in future years and continue to exert similar influences.

• High Growth Demand and Conservation

Many people in the state believe that population growth in some locations (and the resultant demands for increased electric supplies) cannot continue indefinitely without some type of energy shortage (gas, electric, etc.) occurring. They believe, therefore, that certain energy conservation measures need to be instituted. The Governor's Energy Conservation Office supports an electricity conservation and peak reduction program having the effect of slowing

the growth of consumption. Based on current projections, existing facilities would then be sufficient for a longer period of time.

Among the measures suggested were:

1. Peak pricing for electricity

2. Mandatory building and appliance energy efficiency standards

3. Increased use of waste heat by industry

The rationale behind these measures is that it is generally cheaper to save energy with more efficient buildings, products, and management, than it is to produce more energy.

• Water Resource Problems

Whether there will be enough water for all needs, including water for energy conversion, such as in oil shale retorting, and energy production is a common state concern. Further, water rights, necessary to ensure an adequate water supply, are becoming more costly and difficult to secure.

Issues

• The allocation of water among the various uses--irrigation, energy production, municipal, and industrial--is an issue that will need to be settled in the future. Diversion of Western Slope water to the Eastern Slope constitutes another issue requiring resolution. In this case, Western Slope interests feel that the water is needed for electric power, coal, and oil shale production on the Western Slope.

• A concern also exists that the zero discharge goal set by the Federal Water Pollution Control Act Amendments of 1972, if implemented as planned by 1983, will decrease water supply and cause problems for downstream users.

• The Public Utilities Commission has encouraged utilities to coordinate system planning in an effort to minimize the need for short-term solutions on individual systems and on the operation of less economical generation units. Such planning would give maximum benefits to the consumer and create minimum environmental impact.

• The question of who should pay for air and water pollution control equipment and for visual or aesthetic improvements, such as underground facilities, is another important issue. How these improvements can be financed--possibly by tax exempt bonds--and whether tax credits or exemptions should be granted are additional unresolved issues.

• A further issue is whether there should be a time limit schedule on litigation involving utilities.

PRESENT ELECTRIC POWER CONCERNS

Needs

- Interpretation of federal environmental controls giving recognition to varying requirements of different states.

- Application of load management techniques to improve generating plant load factors, including better system interconnections.

- Clear resolution of factors affecting nuclear generating plants, including cost analysis and definition of safety questions.

- Development of prime energy sources within existing constraints of cost and availability.

Problems

- Rising costs of production in existing plants.

- Steadily climbing estimates of construction costs for new plants, resulting in part from delays in issuance of licenses and in part from uncertainty over availability of prime energy sources.

- Steadily increasing consumer demand despite increased cost to the consumer as demand rises, in opposition to historic trends.

- Public resistance to proposals for increasing generating capacity, whether by nuclear, conventional fossil-fueled, or hydro-electric means, an obvious inconsistency given rising consumer demand; protests at rate increase proposals; and disregard of conservation requests.

Issues

- Development of coal resources.

- Provision for transportation of Iowa coal from mine site to generating plant (truck, rail, pipeline).

- Provision for disposal of wastes from generating process.

FUTURE ELECTRIC POWER CONCERNS

Needs

- Ways to reduce energy consumption and demand.

- More efficient energy transmission systems.

- Imposition of techniques to reduce load peaks.

- Development of alternative energy sources.

Problems

- Water supply for energy production.

- Long lead time required for construction of new facilities.

- Cost of plant retro-fit programs aimed at reducing consumption through efficiency.

- Uncertainty about cost analyses of proposed alternate energy sources.

Issues

- Provision for multiple use of available water supply, including agricultural and industrial uses.

- Shift in emphasis from non-recurring prime energy sources, primarily fossil fuels, to renewable energy sources - solar, wind, hydroelectric.

KANSAS

PRESENT ELECTRIC POWER CONCERNS

Needs

- Less stringent federal environmental controls

Any action that would modify environmental controls would be of help and value. Present requirements result in untold man-hours and paper work that, in our opinion, produce questionable results. The same end product can be achieved by an application of common sense and rationale. This applies to power or any other resource.

Problems

- Delays in issuing federal power licenses

Delays have been encountered in the licensing of the Kansas Gas and Electric Company nuclear plant proposed for southeastern Kansas, and additional delays appear to be emerging because of a water supply contract (for the nuclear plant) between the state and the power company.

Issues

- Development of coal resources in or out of state

Coal resources within the state are being utilized where economical to produce. Out-state coal resources provide the bulk of the fuel requirements, but issues have arisen in some areas of the state between environmentalists and coal operators.

FUTURE ELECTRIC POWER CONCERNS

Needs

- Ways to reduce energy consumption

Savings on energy consumption is part of the state energy policy and is applicable to present as well as future conditions. Suggestions for reducing consumption have been made, and energy conservations proposals have been submitted. These range from car-pooling to public transportation subsidies. Solar and wind power have been promoted as energy sources.

Issues

- Conversion of water use from agricultural to industrial

This will probably become a major issue. Under state law, such conversion could be made but at a price which very likely would result in a problem. This matter has surfaced in a present conflict over a power company's water supply contract. The issue is being debated in the legislature.

MINNESOTA

Minnesota has an Energy Agency and an emergency allocation plan. No comprehensive energy policy has yet been established, but one is being proposed.

Water supply for energy production and conflicts in water use are not a problem.

MISSOURI

Part of the problems and needs in electric power production are expressed in a legislative bill presently before the Missouri Legislature. The bill is now in committee in the Missouri General Assembly.

The proposed legislation follows two important themes:

1. One-stop shopping. Consolidation of state-level permits (Missouri has three separate permits) into a single process aimed at streamlining the approval procedure is sought. This concept also pre-empts local zoning, where such exists, and substitutes substantial local input through public hearings. The state does not anticipate a problem in this respect since new facilities must be sited in sparsely populated areas, which typically have not enacted planning and zoning ordinances.

2. Comprehensive environmental review. Currently, Missouri can only review air and water quality impacts. Further, the Public Service Commission does not review projects for environmental impacts. Instead, the Commission's only responsibility is to certify plants located outside designated service areas. New statutory authority should include other natural resource impacts and energy-related matters (role of energy conservation, costs of energy production, alternative fuels, impact on rates).

Creation of a siting commission by the legislation would make possible thorough and systematic consideration of policy matters involved in locating major energy facilities and state energy development.

The bill was originally introduced because the Department of Natural Resources felt that legislation was essential to minimize the adverse environmental and quality of life effects caused by major energy facilities.

Finally, greater use of coal and nuclear fuels are expected in Missouri because of the lack of available alternative technologies for energy development.

MONTANA

ELECTRICAL POWER NEEDS, PROBLEMS AND ISSUES INVOLVING LEGAL, POLICY AND INSTITUTIONAL CONCERNS

Needs

• In Montana, electrical power is supplied by federal agencies such as the Bonneville Power Administration, Bureau of Reclamation, Corps of Engineers; by investor-owned electrical utilities, such as the Montana Power Company, Montana-Dakota Utilities, Pacific Power and Light, Black Hills Power and Light Company; and by Rural Electric Associations. Because of this wide diversity of suppliers, a uniform system of recording electrical consumption for all agencies and companies is necessary as a basis for future planning.

• Uniformity and coordination are continuing needs in other ways too. One is the need for a statewide siting survey to identify areas unsuitable for transmission line location. Another is a mechanism by which local, state, and federal agencies, utility companies, and citizen groups can work together on issues such as energy growth, consumption policies, conversion policies, and siting policies. Also, a regional energy data bank is called for in the near future, and a computer program dealing with load flows and stability studies could help establish the need for new facilities and system alternatives.

• Underlying all electric power needs is also a need for a comprehensive public involvement program. The public needs to be made aware of energy-related issues and have an opportunity for input into the decision-making processes.

Problems

- No serious effort by the federal government to establish conservation techniques and reduce peak loads.

- Jurisdictional problems between the federal and state government regarding the siting of energy facilities on federal land.

- In the case of minemouth generation, the recipients of energy do not pay the consequences in terms of environmental trade-offs thus, there is decreased incentive to conserve energy.

- Inexpensive hydropower in the Northwest promotes energy-intensive industries, and does not advance the concept of conservation.

- Lack of state government and citizen participation in regional planning councils, such as the Northwest Power Pool and the Western Coordinating Council.

Issues

- Research into load management techniques.

- Conventional method of determining electricity rate base vs. the new "life time" system.

- Should energy production be in the public or private sector?

- Determination of optimum rate of coal consumption for the benefit of long-range use.

- Continuation of tendency to meet energy demands instead of cutting back demand.

- Understanding of differing energy forms, i.e., natural gas vs. electricity.

NEBRASKA

PRESENT ELECTRIC POWER CONCERNS

Needs

- One of the present needs in Nebraska is improved electrical service facilities and systems.

    a. Better system inter-ties are needed within the state to connect the eastern and western portions and to serve all municipalities in periods of emergency.

    b. More three-phase service lines are required in rural areas to meet constantly increasing irrigation and farm loads.

c. Optimum utilization of the generating potential of the dams on the Missouri River is needed to supply state demands.

- Public education about the issues and problems facing the power industry.

  a. It is necessary to educate people to the fact that fossil fuels and water resources are not unlimited, and that careful management is needed to assure a continued supply of energy of all kinds, including electricity.

  b. It is also necessary to educate the public to the utilities' need to raise capital, primarily through bonding, for expansion of facilities.

  c. It is also necessary to educate the public to the need for the construction and operation of nuclear power plants.

- Improvements in regulatory procedures are needed.

  a. More reasonable environmental standards are required.

  b. Regulatory procedures need to be amended to eliminate or minimize delays and expedite licensing and regulation procedures.

  c. Some method, such as a financial commitment or bond, is needed to insure that intervenors in licensing procedures are serious, responsible parties, and that applicants are reimbursed for losses due to delays if the intervenor is found to be arbitrary or irresponsible.

- Establishment of national and state policies is needed for areas related to electric power.

  a. First, a definite national energy policy concerning fossil fuels and other forms of energy used in the generation of electric power is needed to determine how future plants in the state should be designed.

  b. Secondly, a policy relating the use of water to national energy policies, including all the waters of the Missouri River Basin, is needed to determine state power policy and, therefore, other water uses in the state.

  c. After national policy is available, a state energy policy is needed by the utilities for planning. Further, a state policy on power plant siting or land use planning and the use of water by power plants may be required.

Problems

• One of the basic problems in the power industry in this state is the escalating cost of producing and distributing power. New facilities, such as inter-ties and three-phase distribution lines, are becoming increasingly more expensive. Funding these improvements and constructing new generating plants requires substantial amounts of capital, which must be obtained through the sale of bonds. This adds to the cost of construction, and requires sound financial conditions to attract investors.

Numerous delays are also adding to construction costs. Environmental regulations have not only added costs for features not previously included in power facilities, but environmental impact assessment and filing procedures have added to the time required to obtain necessary clearances for construction. The number of regulatory and licensing authorities and the complexity of their procedures and requirements results in lengthy proceedings that delay construction, thereby increasing costs. The numerous authorization proceedings also offer many opportunities for opponents to delay construction at different stages of planning and authorization. While it is necessary to insure that an opportunity is provided for all views to be presented, it is important to insure that intervenors are serious and responsible parties, and that they are not allowed to delay construction arbitrarily.

All these factors contribute to increasing costs which must be offset with rate increases. The rate increases, in turn, create a problem in public relations.

• There are a number of problems encountered in attempting to educate the public on the electric power situation. It appears that a certain portion of the public does not really accept the need for conservation and careful management of resources and electricity. The increasing use of electric power for heating in homes demonstrates this lack of awareness. Also, the public does not realize that nuclear power will have to play some role in generating electricity in the future. The technology for producing electricity from renewable resources such as solar power and wind is not currently available and may not be for some years in the future. Existing systems such as fossil fuel and nuclear plants will be needed to supply the increasing future demand until other types of generation are fully proven. Electric utilities, particularly those with a responsibility for generating power, are experiencing problems in raising capital for expansion of facilities and construction of new plants. In many cases, rate increases are needed to raise required capital or prove effective bonding capability.

• Current environmental standards are not always based on the most cost-effective means of improving environmental quality. Also, it appears that standards applicable in one location may not be appropriate for another, and that some regulations are not reasonable for the given time frame.

• The lack of a federal energy policy concerning fuels (Alaskan oil and gas, other oil and gas, nuclear, coal), water for energy and other uses, and the role of electric power versus fossil fuel and solar energy makes establishing state policy very difficult. Furthermore, the absence of such a policy makes long-range planning by utilities very difficult. Without long-range planning, power or utility districts cannot determine projected plant needs, and the state cannot determine whether sites need to be reserved or whether land use planning is necessary.

Issues

• One issue basic to the state is the role of northern Great Plains coal in the national energy picture; how it will be developed, and how it will affect other state resources, particularly water. Assuming that the coal resources of the region must be developed, Nebraska will be directly affected by the manner in which the resource is developed and transported. The first question to be addressed is whether coal should be used to generate power near the mines or whether it should be moved farther east across Nebraska. If it is to be moved across Nebraska, should it be moved by pipeline or railroad? If power is generated at the mine, will the required consumption of water affect Nebraska more than the transmission lines required to deliver the electricity?

• Another issue related to the method of developing coal concerns the regulation of strip mining in upstream states. Should the production of coal and the generation of power be allowed to interfere with surface and ground water flows that, if altered, might interfere with streamflow in Nebraska? Should strip mined areas in the west be reclaimed with water currently or potentially used in Nebraska?

The reservation of suitable sites for power generating facilities would require changes in the procedure for issuing water rights and the preference of water rights. If it becomes necessary to reserve the sites, establishment of a policy on land use planning or power siting laws would be required.

FUTURE ELECTRIC POWER CONCERNS

Needs

• In the future, greater generating capacity will be needed to meet increasing needs of the public. More power will be needed to increase the amount of irrigation in the state. In addition, new power will be needed to supply users in the field of transportation that will convert to electricity.

• To minimize the amount of additional power needed, new methods of increasing efficiency in producing and transmitting electricity and using water in generation will be required. As the demand for water becomes greater, methods of cooling generating plants with less water will be required. Also new methods increasing the efficiency of water used for irrigation will conserve water as

well as electricity. Many other techniques for increasing efficiency of power users are also needed.

• Research is needed to find ways of increasing efficiency in the industry and to discover alternative means of generating power.

• It will be necessary in the future for the public to accept an expanded responsibility for nuclear power and for the industry to develop acceptable means of disposing of nuclear wastes.

Problems

• Building more generating plants to meet the increasing demand will produce more and greater effects on the natural environment. The need for more fuel and water to operate these generating plants creates a need for more energy conservation and greater efficiency in producing, transmitting, and using electrical power.

• The problem of producing more power involves improved public acceptance of nuclear power plants, until better alternatives are available.

• One of the problems with nuclear power plants is the lack of effective means of disposing of nuclear wastes. This problem will become increasingly more serious as the number of nuclear plants expands.

Issues

• Future issues do not appear to be separable from current ones.

NORTH DAKOTA

PRESENT ELECTRIC POWER CONCERNS

Problems

- Increased sedimentation
- Thermal pollution
- Disruption of aquifers
- Proliferation of water intake and conveyance systems
- Adequate domestic water supplies
- Water quality where multiple use is envisioned
- Reclamation of mined land
- Plant stack emissions
- Social impacts

Legal

• Priorities of water use are articulated in Chapter 61-04 of the North Dakota Century Code. A property right to such water is established only after application of the water to a beneficial use. At the time of application for a water permit, the applicant is granted a priority in time by the State Water Commission. This priority in time is, of course, erased should the application not be approved. The state does have the authority to set aside or reserve specific quantities of water through a "Declaration of Intent."

• Implicit in the need to maintain a quality environment is the need for the state to promulgate a body of rules, regulations, procedures, and standards designed to insure this maintenance. Where such instruments do not now exist, a problem must be seen to prevail. The state is working diligently to identify those areas where new regulations are needed or where existing ones require clarification or expansion. It is recognized that North Dakota's foremost interests can best be served if the lion's share of needed guidelines, etc., are identified and given the force of law prior to development. "After the fact" actions are invariably more difficult to administer.

Institutional Concerns

• As water use grows, added monitoring and/or policing of such use under the state's water permit granting authority will be necessary. Procedures now being followed by the state in granting industrial and/or other types of water permits are adequate in terms of the state's capacity to act within a reasonable period of time. The continued ability to respond in a timely and orderly manner could be strained by a deluge of applications.

• Water use efficiency, particularly as it relates to lignite utilization for energy production, is a function of costs - the least efficient usually being the least costly. Efficiencies tend to increase as the availability of the water supply diminishes. Industries locating in North Dakota to utilize lignite resources can expect to encounter rigid standards requiring a high degree of water use efficiency. This will be accomplished, in part, through a comprehensive metering and monitoring system.

• Substantial energy production developments away from the Missouri River would not be possible without diversion from the river to its tributaries. Financing for such a diversion system would be a serious problem.

• Environmental constraints take two forms - those which exist and those imposed at some future time. Existing environmental constraints are directly related to the need to successfully reclaim mined lands; minimize the disruption of aquifers; maintain air and water quality standards; and sustain or enhance the overall "quality of life" for North Dakotans. An example of a constraint which may be imposed at some later date would be the enactment of proposed legislation declaring the Little Missouri a scenic or wild river, thus precluding the construction of water impoundments essential to the coal conversion process.

Needs

- South Dakota has had a sufficient supply of electrical energy since the construction of the Missouri River dams. However, the state now faces the necessity of developing other sources of energy or of purchasing electricity from outside sources, since the Bureau of Reclamation will not be able to meet developing needs beyond 1977.

- Electrical energy needs are growing rapidly in South Dakota. This growth is tied primarily to agriculture, particularly to the growth of irrigated agriculture. It is anticipated that South Dakota's irrigated lands will be increased by about 2 million acres within 50 years.

- South Dakota will need increased capacity in its electrical distribution systems, particularly in three phase lines for irrigation and industrial development.

- The state needs a considerable amount of information on its natural resources. This should be provided through expanded programs in geological surveys and research relating to gas, oil, coal, uranium, and water.

- The state needs more research in the area of energy conservation. This is especially true in both the agricultural and tourism industries, since both are basic to the state's economy and both are large users of energy.

Problems

- South Dakota will be faced with environmental problems as soon as efforts are made to modify the present hydropower system for peaking power. Fish and wildlife interests will strongly opposed impacts upon the Missouri River in the reaches between the dams.

- A very strong public conflict is developing over the use of water for energy development versus other uses. This is especially so for proposals to use water for slurry line transportation of coal.

- The downwind environmental effects of coal development in Wyoming, Montana, and North Dakota are of concern to South Dakotans. This concern includes air and water quality changes, as well as the possibility for inadvertent weather modification.

- Another concern is the environmental effects of coal development on the Black Hills of South Dakota. It is felt that the influx of people associated with development will place added pressures on the Black Hills for recreation and for places for people to live.

Issues

- Water rights is currently a matter of public concern in South Dakota. This is largely a matter of South Dakota's rights in the waters of the Missouri River versus federal, Indian, and other states' rights.

- The use of water for energy development versus other uses is also a matter of public concern.

- The public is questioning the use of the powers of eminent domain, including its use for energy development.

- A major issue currently being examined in South Dakota is the use of the state's resources for water and energy development. For instance, should the state finance and build projects to deliver water for industrial uses, or should this be left to the industry or the federal government?

- Some state agencies are currently working on a proposal for an energy facilities siting act. Whether the public perceives this to be enough of a problem for the enactment of this type of legislation remains to be seen.

WYOMING

PRESENT ELECTRIC POWER CONCERNS

Needs

- Single function of authority for regulation and control of environmental disruptions - principal seat of authority should probably rest with the state under guideline criteria developed by federal and state agencies.

- National energy policy to establish realistic parameters for procedures, goals, and objectives.

- Clarification of water allocation authority on federal reserved lands.

- A defined information base.

Problems

- Lack of factual analysis of the actual energy situation.

- Lack of acceptable and approved standards and regulations for the reclamation of strip mined lands.

- Undefined objectives for various sources of power production.

Issues

- Socio-economic impact on communities.

- Taxation of mineral resources and the allocation of tax revenues so derived.

- Environmental impact of energy development.

- Developing water supply for energy production.

- Rate of energy resource development.

- Planning for and control of development.

FUTURE ELECTRIC POWER CONCERNS

Needs

- Energy conservation programs.

- Research and development of alternate energy sources.

- Legislation to influence policies for energy development and consumption.

- Recognition of states' rights and responsibilities.

Problems

- Lack of adequate information.

- Fractionalized responsibility, coordination, and authority among activities associated with the energy scenario.

- Allocation of scarce water supplies to energy production.

Issues

- Utilization of resources in or out of state.

- Justification for the allocation of water to industrial uses in preference to other applications.

- Balancing industrial economic growth and environmental preservation.

COMMON STATE CONCERNS

Present

Needs

1) Better or more reasonable interpretation of federal environmental controls so as to recognize requirements of different states and reduce the time required in clearing permits for construction of power plants.

2) Public education on energy problems and a need for conservation.

3) Establishment of a national energy policy.

Problems

1) Delay in approval of new power plants results in increased costs.

2) Lack of federal effort to establish conservation techniques and reduce peak loads.

3) Lack of factual analysis on the energy situation as it relates to water, social, economic, and other factors.

Issues

1) Role of northern great plains in energy production - to produce electricity near coal areas or to ship the coal to areas of major energy consumption.

2) Transfer of water from agricultural and other uses to energy production.

3) Continuation of the tendency to meet increasing energy demands *vs.* conservation of energy.

Future

Needs

1) More efficient energy transmission systems.

2) Development of alternative energy sources.

3) Ways to reduce energy consumption and demand.

4) State guidelines and laws regarding energy development and use.

5) Power facility siting laws.

Problems

1) Longer lead time required for the financing and the construction of power plants because of increasing state and federal reviews and permitting requirements.

2) Adequate water supply for energy production.

3) Uncertainty about proposed alternate energy sources.

4) Public acceptability of nuclear power plants and waste disposal methods.

Issues

1) Balancing industrial economic growth and environmental preservation.

2) Utilization of energy resources (coal) in or out of the producing state.

3) Water use for energy production vs. other uses.

4) Development of alternate energy sources vs. coal development.